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ABSTRACT

The National Science Foundation (NSF) supported more than 600 inservice teacher training programs between 1984 and 1989 under its Teacher Enhancement Program (TEP). Two studies were undertaken of TEP: the first was a survey of the 600 Principal Investigators (PIs) who had operated inservice teacher enhancement projects and the second, a survey of individuals who had participated in the projects. The key findings from these studies have been merged for presentation in this summary report, designed to be reviewed quickly in order to find out what was learned from the studies. The findings are presented in 26 bar graphs with a brief commentary on each. The findings are grouped according to topic and PI or participant: areas of science receiving major emphasis in TEP projects, by grade level; areas of mathematics receiving major emphasis in TEP projects, by grade level; discipline of awardees' highest degree; most frequently held goals and objectives; instructional methods and materials as reported by PIs and participants; assessments of the usefulness of various teaching methods and materials; assessments of project outcomes; participants' reports of changes in their teaching activities; changes in student characteristics since TEP experience; post-project activities; other sources of financial or in-kind support; focus of teacher recruitment; methods used for general recruitment; average grade level taught by TEP participants; significant project accomplishments, by type; greatest impact of projects; specific lessons learned; benefits to participants' students; particular model with greatest promise for enhancing teacher skills; important changes that might be made in projects; suggestions for NSF about support for PIs; and suggestions on ways for NSF to improve operation of its program. The report concludes with a commentary on the achievement of TEP objectives from four perspectives: those of the TEP itself, the Division of Teacher Preparation and Enhancement, the Directorate of Education and Human Resources (EHR), and the NSF as a whole. (LL)

ED 372 026

A Study of

NSF TEACHER ENHANCEMENT PROGRAM (TEP) PARTICIPANTS AND PRINCIPAL INVESTIGATORS:

1984-1989

Volume I: Summary Report

Abt Associates Inc.
Center for Science and Technology Policy Studies
Cambridge, Massachusetts

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NOTICES

The study of TEP Participants was performed under Contract No. BAC 9002179, Task Order No. 9154854, between the National Science Foundation and Abt Associates Inc. The study of TEP Principal Investigators was performed under Contract No. BAC 9002179, Task Order No. 9115305, between the National Science Foundation and Abt Associates Inc.

This Summary Report is based upon a longer report prepared by Stephen Fitzsimmons, Robert Burnham, Kenneth Carlson, and Diane Stoner (1993), entitled ***A Study of NSF Teacher Enhancement Program (TEP) Principal Investigators and Participants: 1984-1989, Volume II Technical Report*** Cambridge, MA.: Abt Associates Inc. Copies of the detailed report may be obtained by writing the Division of Research, Evaluation and Dissemination, Directorate for Education and Human Resources, National Science Foundation, 1800 G Street, N.W., Room 1249, Washington, D.C. 20550.

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ACKNOWLEDGEMENTS

The authors wish to express their appreciation to Dr. Roger Baldwin of the National Science Foundation, who served as Project Officer for the Teacher Enhancement Program (TEP) Principal Investigator and Participant survey, and who was consistently supportive throughout all phases of the two studies. We also express our appreciation to Dr. Floraline Stevens, who served as Project Officer during the latter phase of the Participant Survey and who assisted in the completion of this report. Other NSF staff who also supported this project included Drs. Frances Lawrenz and Ken Travers of the Division of Research, Evaluation and Dissemination, Directorate of Education and Human Resources.

Dr. Iris Weiss, President of Horizon Research Inc. provided many helpful comments and suggestions to the authors in our preparation of the survey questionnaires. We also owe thanks to Dr. Mary Ann Scheirer, who consulted with the National Science Foundation on the evaluation plans and survey instruments.

A number of Abt Associates staff performed key roles in this study. Ms. Diane Stoner made valuable contributions to the questionnaire design and served as overall survey coordinator. Mr. Kenneth Carlson served as a senior analyst on the study, with principal responsibilities for statistical preparation and selected analyses. Mr. Robert Burnham worked on both analyses of the data and presentation of the findings. Mr. David Deal and Mr. Stephen Heinig contributed to the organization of materials, development of the data base, and selected analyses in the study. Dr. Larry Kerpelman served as senior research reviewer for the study, while Mr. John S. Tilney, Jr. provided management support to the project. Finally, Ms. Andree Powell-Williams served as the senior secretary on the project.

The authors wish to express their special appreciation to the more than 450 TEP Principal Investigators and thousands of TEP participants who responded to the surveys and provided many useful comments and suggestions on the operation of the TEP projects and on future directions that may be taken by the program.

Cambridge, Massachusetts
February, 1993

PREFACE

The National Science Foundation supported more than 600 inservice teacher training projects between 1984 and 1989 under its Teacher Enhancement Program (TEP)[1]. This is but one component of a comprehensive NSF effort to assure that the nation's future supply of qualified scientists, mathematicians, and engineers is adequate for the challenges ahead and that American citizens are able to function effectively in a technologically intensive world.

In 1990, the Division for Research, Evaluation and Dissemination (RED)[2] undertook the first of two studies of TEP, in which a survey was conducted of the 600 Principal Investigators (PIs) who had operated inservice teacher enhancement projects. This survey sought to learn about their goals for their TEP projects, who they sought to reach, how participants were recruited and from what types of schools, how PIs ran their projects, who helped them, and how PIs assessed the impact of their projects upon the participants. Subsequently, a second survey was conducted in 1992 of individuals who had participated in these projects in order to learn, first hand, from the participants, about their experiences with the TEP projects and what they believed were the major impacts. The findings from both of these studies have been merged in the present report.

Several lessons have been learned in the course of conducting these studies and are worth noting at the outset. First, these two studies of TEP projects provide an unusual program evaluation opportunity in that this report builds upon data and observations provided both by the TEP project PIs and by participants in the TEP projects. The second study of participants obtained information complementary to the earlier survey of PIs. The perspectives of participants on many of the same questions asked of PIs provide a form of validation regarding earlier PIs' assessments of project impacts. If both PIs and participants independently confirm that something was accomplished by a project, we may have greater confidence in the ability of PIs to assess the impacts of their

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[1] *In this report, the acronym TEP is used to designate the Teacher Enhancement Program. Within the National Science Foundation, the acronym TE is used.*

[2] *At that time, the name for this division was the Office of Studies, Evaluation and Dissemination (OSED).*

projects on their participants. In fact, many such instances of correspondence were found between responses provided by these two study groups (and are reported upon throughout this volume).

Second, in this report it is recognized that participants, most of whom are practicing teachers, do not necessarily constitute a homogeneous population. Teachers in elementary schools are unlikely to have the same needs with respect to inservice learning as their counterparts from secondary schools. In order to deal with this consideration, various relationships among the findings are examined and differences among participants as a function of grade level are noted.

Third, since the awards examined cover a six year time frame, the projects themselves may have changed over time. Thus, data were analyzed by cohort year and where changes occurred over time, they are commented upon.

This volume provides the reader a *summary* of many of the key findings from this evaluation. It was designed to be reviewed quickly in order to find out what was learned from the two studies. However, much of the richer detail had to be omitted. The companion Volume II provides more technical detail on the studies. Volume II is designed for use by two audiences. First, for *NSF program officers*, Volume II provides extensive details on the study design, findings on many separate topics, the relationships among various findings, and conclusions and recommendations. In addition, special exhibits are included that provide quotations from both PIs and participants on a variety of questions concerning the impacts of the TEP projects, lessons learned, "best" models for in-service programs, and so forth.

Second, for the *technically oriented reader*, Volume II provides details on such matters as sampling and weighting procedures, and complete statistical tables and copies of the questionnaire are provided.

Finally, both databases are available in electronic form to permit additional analyses of specific questions that educators and scientists may have.

Recommendations derived from the surveys have been made with two objectives in mind. First, to suggest any improvements in the operation of the program itself that will, over the long run, further enhance its effectiveness. Second, to ensure that subsequent evaluation efforts will contribute the most policy- and program-relevant information to the staff of NSF. It is important to note that the recommendations presented in this report are based upon the responses to various questions posed to PIs and participants involved with TEP projects during the period between 1984 and 1989. In turn, these awards were operating under program guidelines issued for applications

made during those fiscal years. Thus, these recommendations do *not* take into account changes in the TEP policies, program, and guidelines made in subsequent years. In the interim period, a number of changes, in fact, have been made. According to NSF officials, "since the time of this study, the program has nearly doubled in length of training and the teacher stipend; allows for 5-year projects; requires more evaluation and follow-up; requires administrative support in home institutions; and focuses more on leader teachers and district-wide system projects." In this sense, a number of recommendations in this report provide a form of external support to changes already made.

Readers wishing to obtain more details on this study are invited to contact the Division of Research, Evaluation and Dissemination, Directorate for Human Resources, National Science Foundation, in Washington, D.C.

SUMMARY OF FINDINGS

Enhancing Science and Mathematics Education in America

In response to a growing national consensus on the need to improve the quality of science and mathematics education provided to our nation's school children, the National Science Foundation (NSF) initiated its **Teacher Enhancement Program (TEP)** in 1984. The goal of TEP is to enhance the quality of education provided to the nation's school children by supporting effective in-service education programs for science and mathematics teachers in elementary, middle, and senior high schools throughout the country.

Through TEP, NSF is also interested in promoting participation among groups presently underrepresented in the sciences, including women, minorities, and persons with physical disabilities. A further goal of the TEP is to foster the development and dissemination of improved models for in-service education programs for science and mathematics teachers across the country. Finally, NSF seeks to increase the impact of its programs by encouraging financial and in-kind support from other sources.

During the first six years of the program, 599 TEP projects were funded throughout the United States, with a total Federal commitment of $160 million. In 1991 and 1992, NSF carried out an evaluation of this program both to assess its accomplishments and to determine appropriate future policies, program operations procedures, and funding levels. A summary overview of the analytic logic that guided the evaluations appears in Figure 1. Based upon a survey conducted of all Principal Investigators (PIs) who received grants between Fiscal Years 1984 and 1989, and a second survey conducted of a sample of TEP participants, we conclude that many of the objectives established for this program are being achieved[3].

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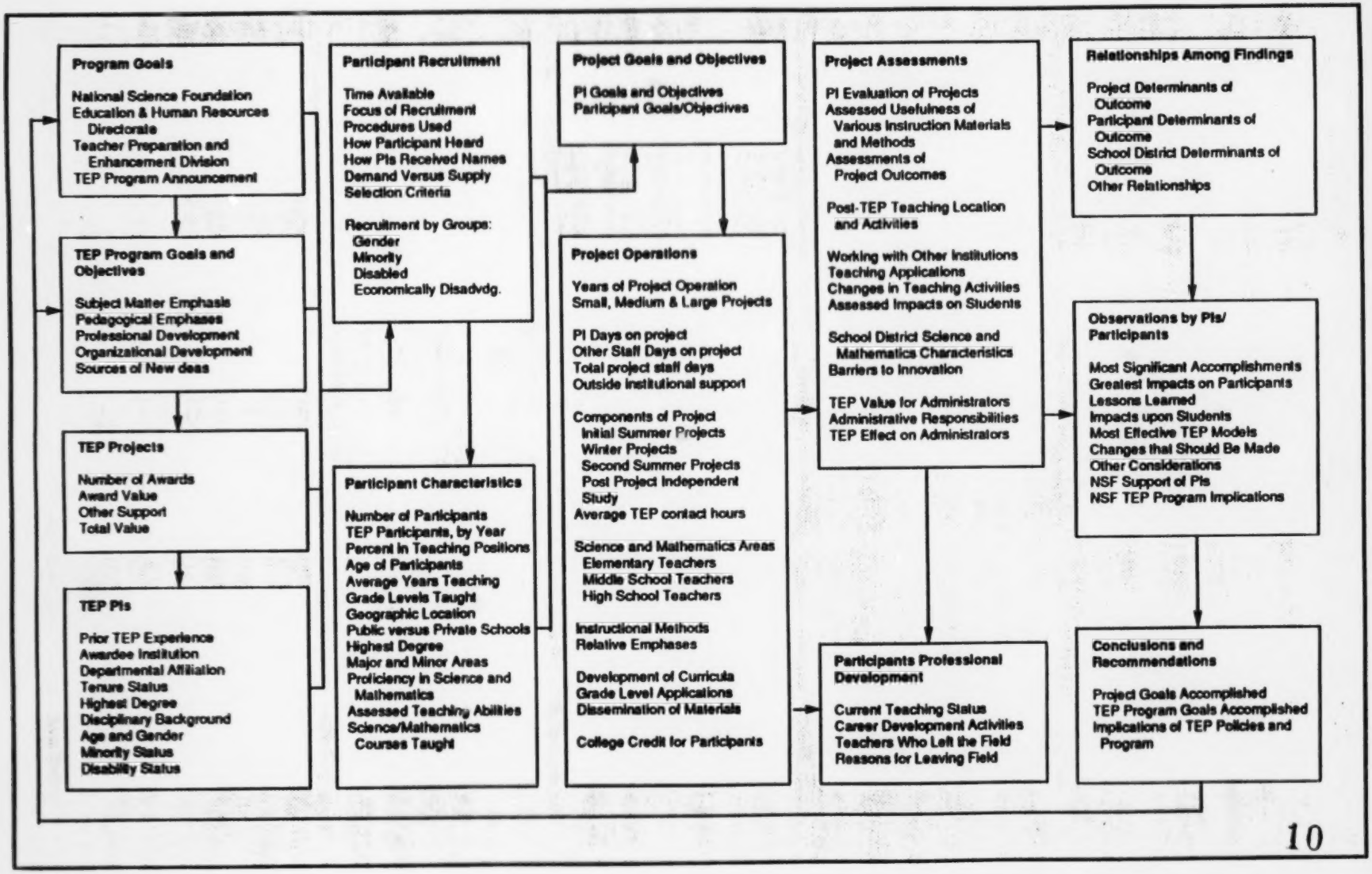
[3] *Seventy-six percent of the PIs, and 59 percent of TEP participants responded to the respective surveys. The information obtained was used in preparing estimates for the entire population, which are reported in this summary. Estimates for the total population were produced based upon several known population characteristics (including award year, number of participants, grade levels taught by participants, and expiration date of award).*

Figure 1

Analytic Logic for the Survey of Teacher Enhancement Program (TEP) Participants

(Incorporating Data from the Earlier Survey of TEP Project Principal Investigators)



Key Findings

Based upon records the PIs had regarding actual participation, it is estimated that NSF has supported the training of more than 63,000 science and mathematics teachers under awards made between FY1984 and 1989. This is the equivalent of 3.5% of all pre-college science and mathematics teachers in the United States[1]. In their assessment of the TEP experience, the great majority of TEP participants (81%) agreed that they would strongly recommend participation in a TEP project to another teacher. Many participants expressed deep gratitude for the inservice opportunity afforded them by TEP; one teacher indicated that participating in the TEP project "was the single most powerful, professional thing I have done. It changed the way I teach everything. Thank you!"[2]

A typical TEP project operated for between two and three years and provided training to just over 100 teachers. Among the 599 TEP projects that provided in-service education, over 90% operated during the summer. According to PIs, participants typically received 120 hours of in-service training in a summer, and many participants returned for a second summer. More than 85% of the projects also offered a program during the school year, in which typically 24 hours of in-service training were provided. Finally, post-summer independent study was reported by a quarter of the PIs (an average of 25 hours).

In-service education focused principally on biological, physical, and earth sciences and mathematics, although other sciences were covered to a lesser degree. The specific emphasis varied somewhat as a function of grade level (see Figures 2 and 3).

The typical TEP project director had earned a doctorate, was educated in a field of science, mathematics, or science education (see Figure 4), taught at a public or private university, and had tenure. Project leaders (and TEP staff) were drawn principally from institutions of higher education, although pre-college teachers and staff from museums and other local institutions also provided in-service training.

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[1] *It is estimated by the Division of Teacher Preparation and Enhancement of NSF that there are approximately 2,000,000 pre-college science and mathematics teachers in the United States. However, because some teachers may have participated in more than one TEP project, it is not possible to determine the exact percentage of the population of teachers that participated in TEP.*

[2] *Many comments on the TEP projects were provided by both PIs and participants regarding various facets of the TEP project and their experiences. These may be found in Volume II, Chapter 11 of this report.*

Figure 2: Areas of Science Receiving Major Emphasis in TEP Projects, by Grade Level

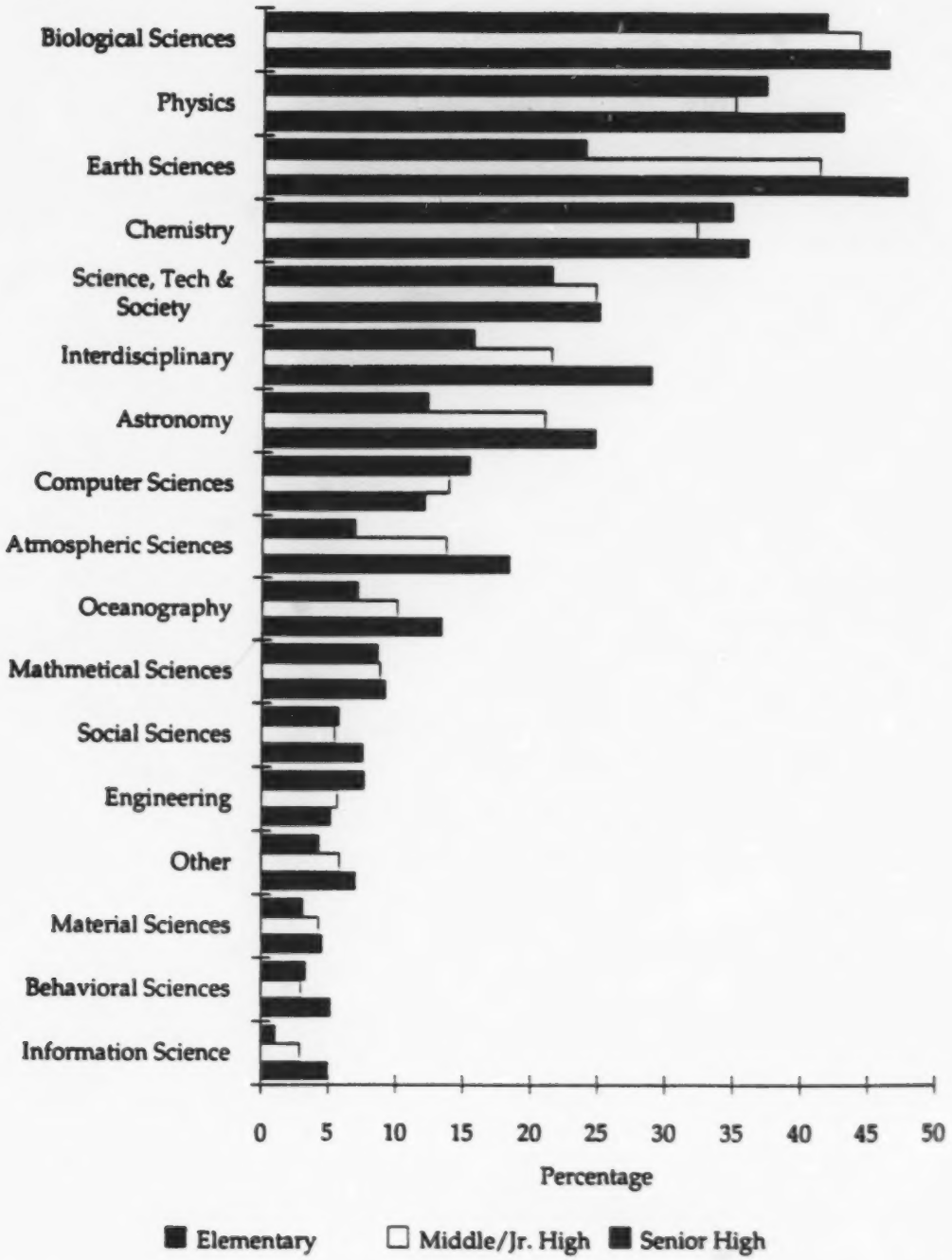


Figure 3: Areas of Mathematics Receiving Major Emphasis in TEP Projects, by Grade Level

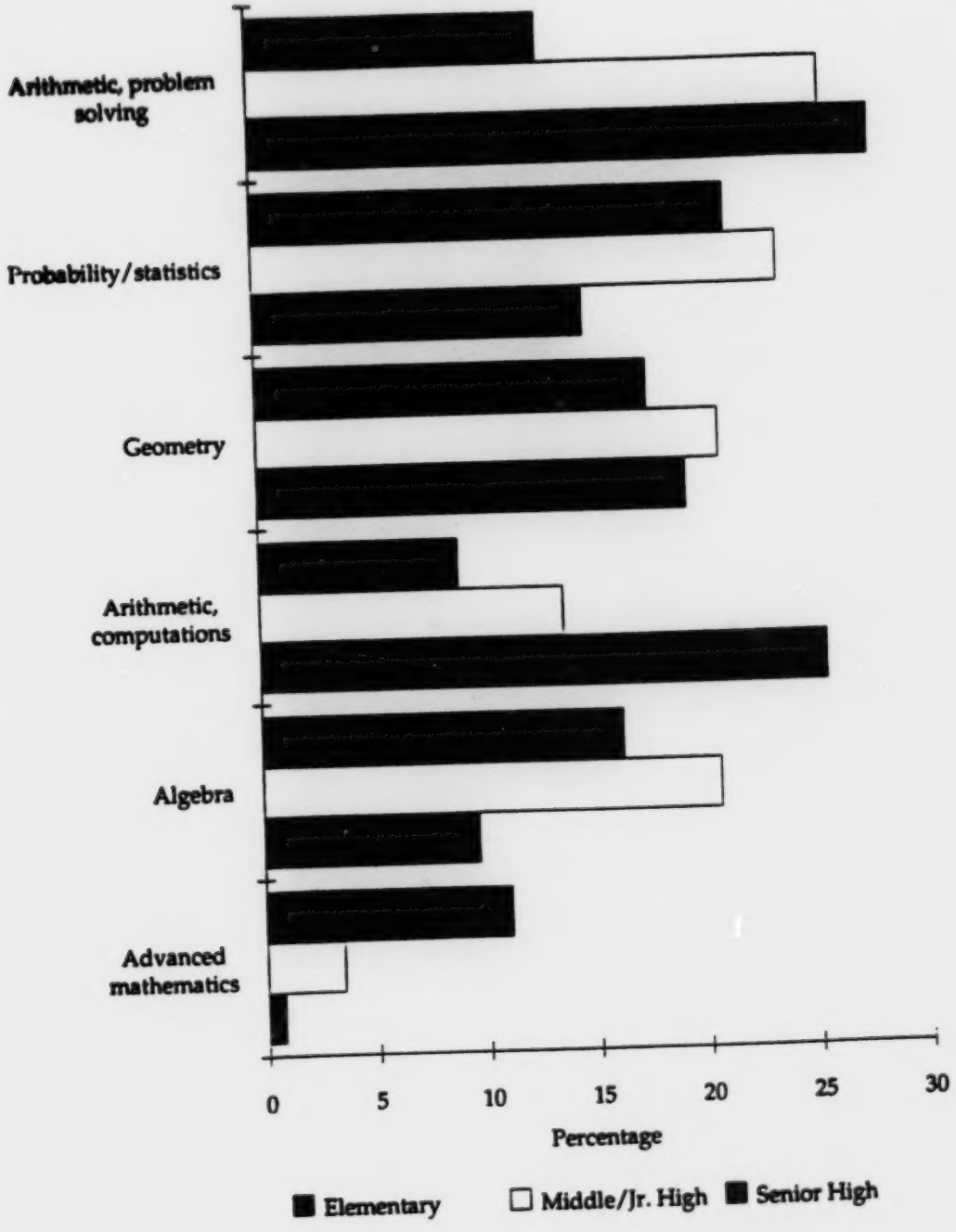
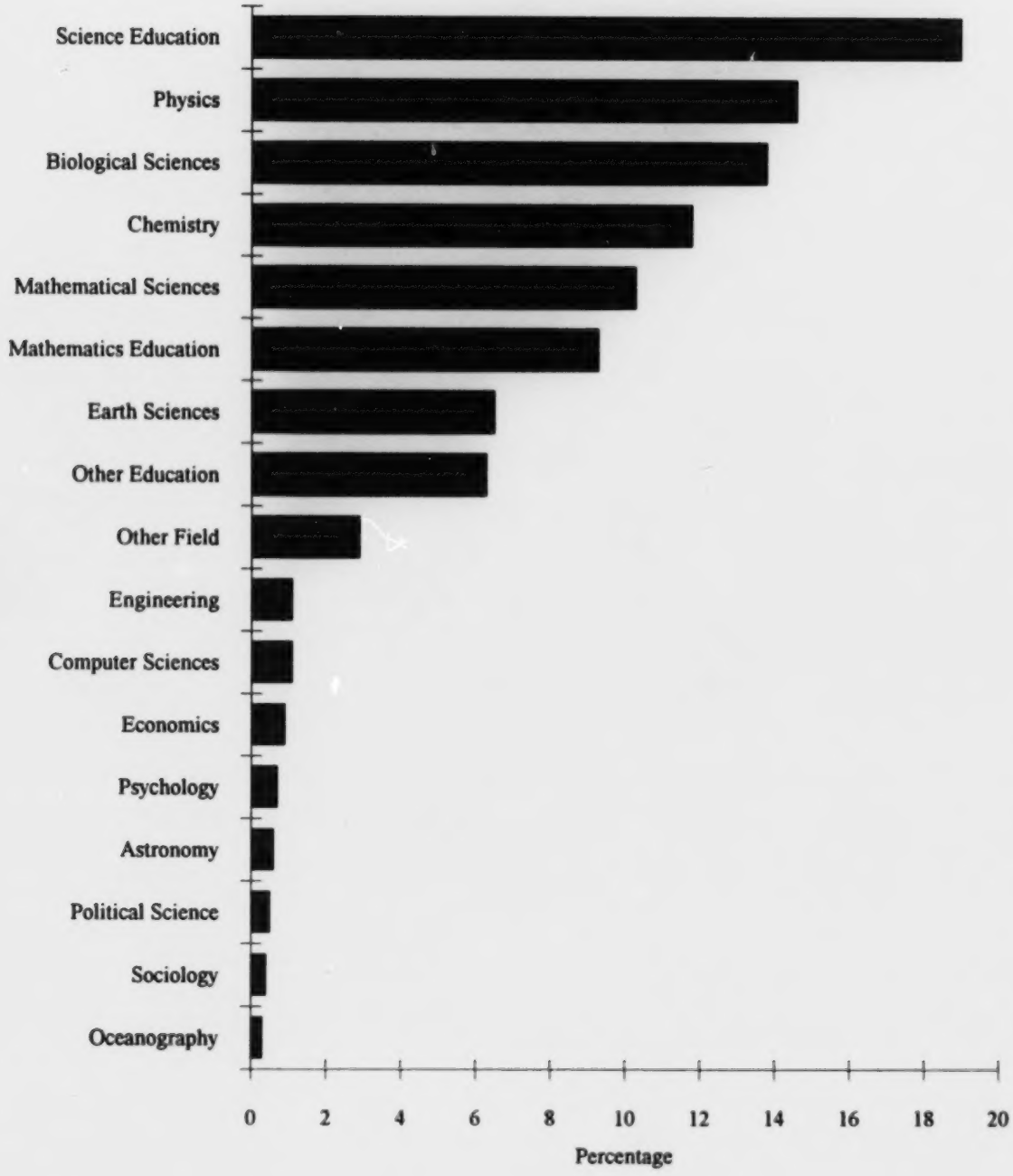


Figure 4 - Discipline of Awardees' Highest Degree



Source: PI Survey - Item 32

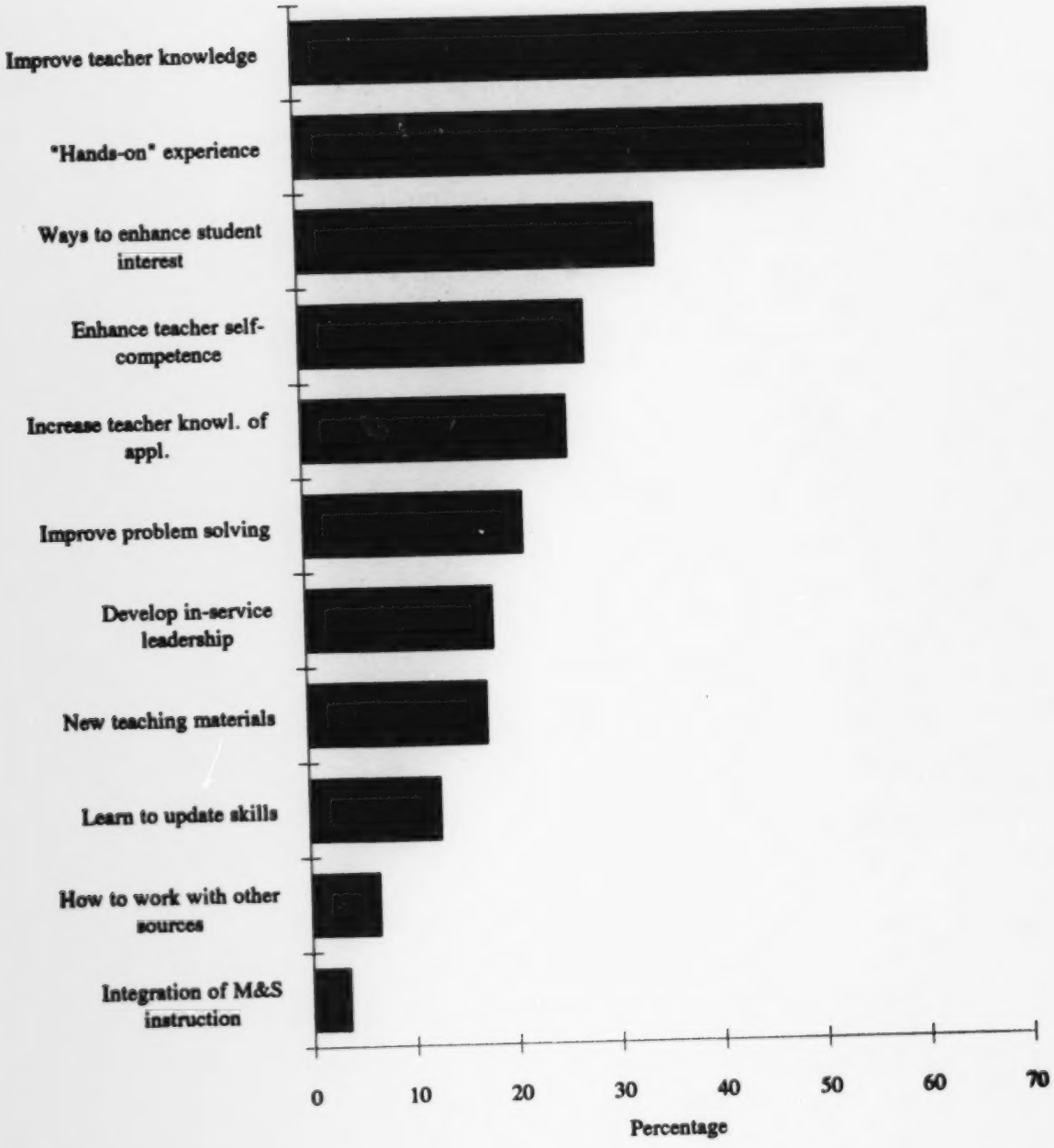
Over the years, the goals most frequently cited by TEP PIs for their projects include: improving teachers' knowledge of science and mathematics content; providing teachers with experience in hands-on instructional activities; and developing ways for teachers to enhance student interest in science or mathematics (see Figure 5A). In recent years, the development of teacher skills for improving student problem-solving, and attention to enhancing student interest in science and mathematics have emerged as central goals. The PIs also reported having a variety of more general and organizational goals, including the addressing of local and regional needs, the evaluation of their projects' effects, insuring the continuance of support of projects upon completion of the grant, and establishing local partnerships among science and mathematics organizations.

Participants were also asked about their own goals and objectives for their projects (see Figure 5B). The participants and PIs stressed the importance of many of the same goals. The objectives cited most often by participants include developing ways to enhance student interest in mathematics and science, increasing their own knowledge of how to apply math and science principles, gaining experience with hands-on activities, and improving their knowledge of math and science content . Participant rankings of their objectives, over time, did not fluctuate greatly.

In terms of instructional approaches used by PIs, as shown in Figure 6A, 86% emphasized hands-on activities, while 45% emphasized small group discussions, and 43% the development of student instructional materials. The TEP participants were also asked about the instruction methods and materials used in the TEP project. As seen in Figure 6B, participants confirmed that hands-on activities are the most often used method in TEP projects; 77% of participants reported that hands-on activities were used often in their projects. Other teaching methods used, according to participants, included cooperative learning groups (42%), lectures (42%), instructor demonstrations (39%), and small group discussion sections (35%).

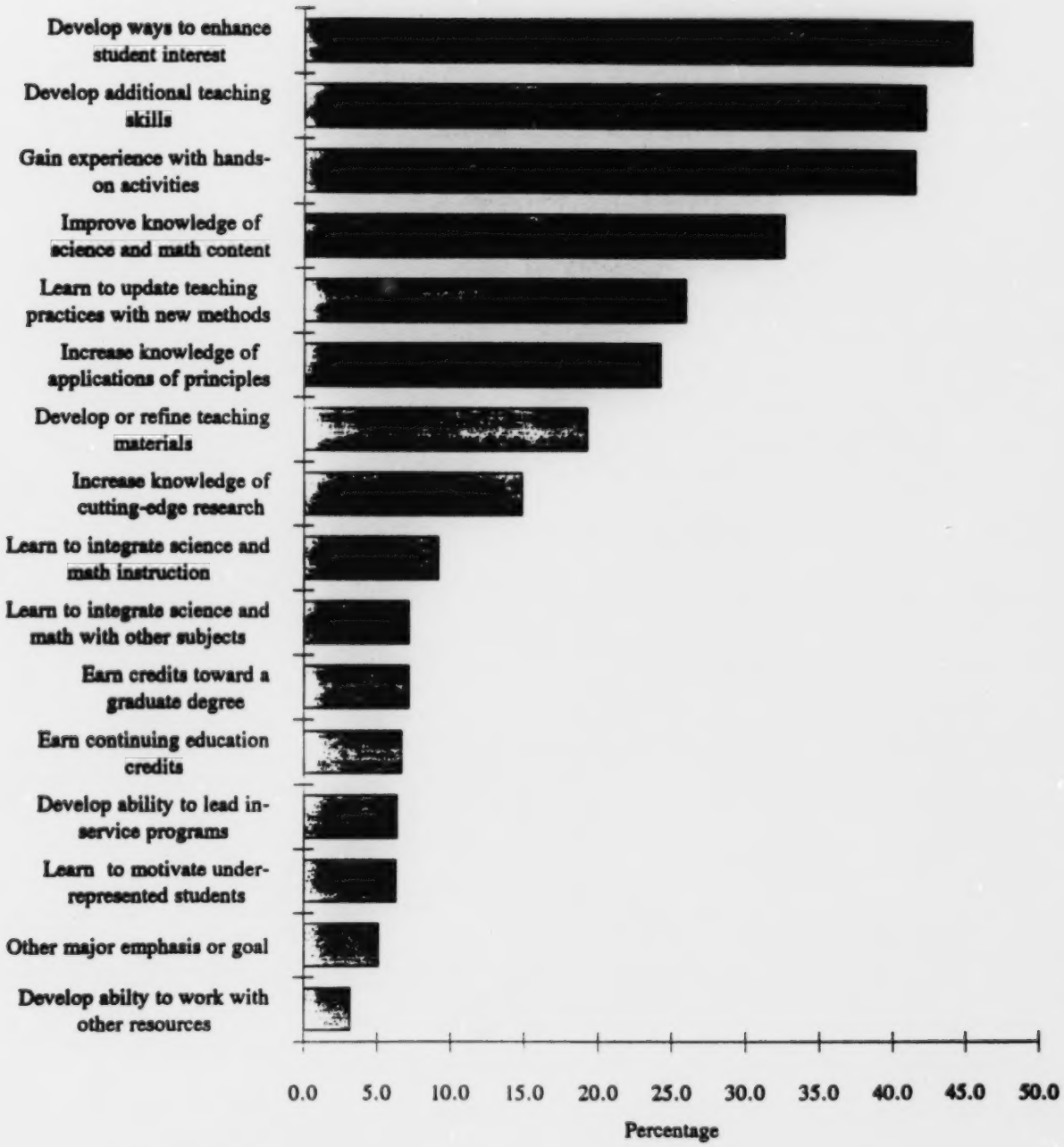
PIs were asked to assess the effectiveness of various in-service education methods. In the eyes of the PIs, effective in-service training projects emphasize hands-on activities, field trips, and the use of cooperative learning groups (see Figure 7A). Development of student instructional materials, small group discussions, use of resource people, instructor demonstrations, and peer teaching also were seen as effective instructional methods. Role playing, lectures, computer assisted instruction, library research, films and videos were seen as less valuable instruction devices. An

Figure 5A - Most Frequently Held Goals and Objectives (Percentage of PIs Rating Goal as 1st, 2nd, or 3rd)



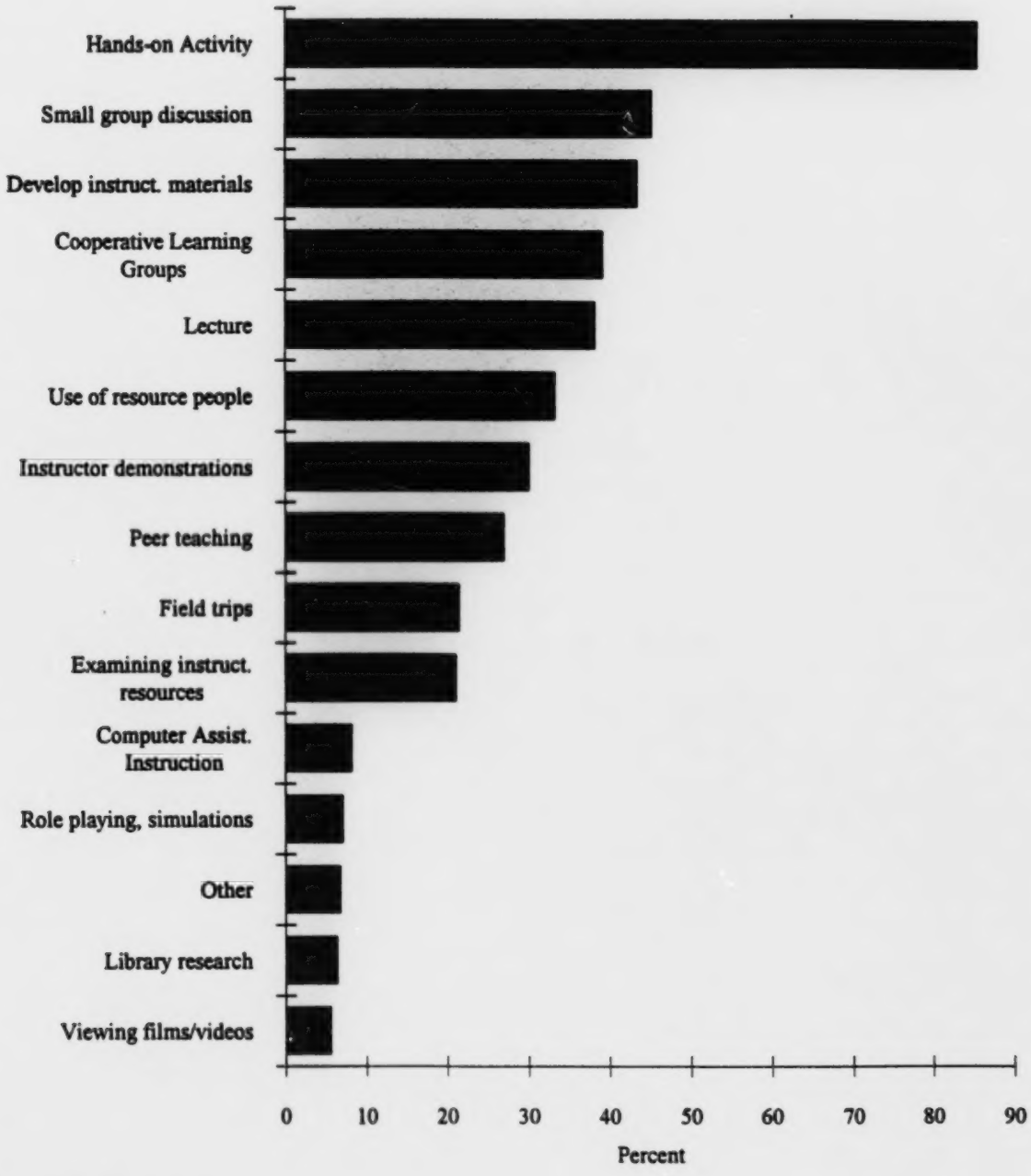
Source: PI Survey - Item 1B

Figure 5B - Participants' Most Frequently Held Goals and Objectives (Percentage of PIs Rating Goal as 1st, 2nd, or 3rd)



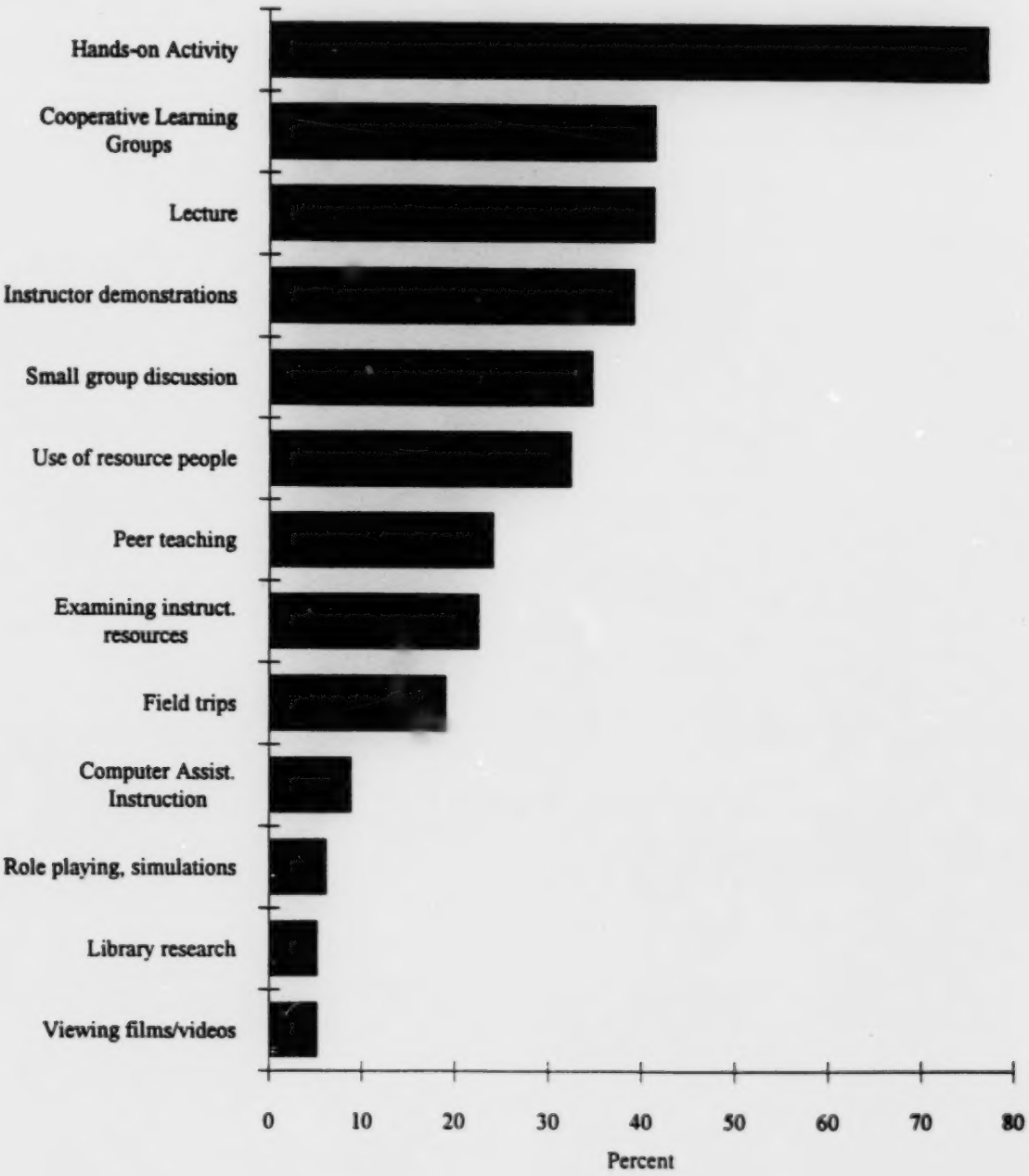
Source: Participant Survey - Item 2A

Figure 6A - PI-Reported Instructional Methods and Materials Used in TEP Project



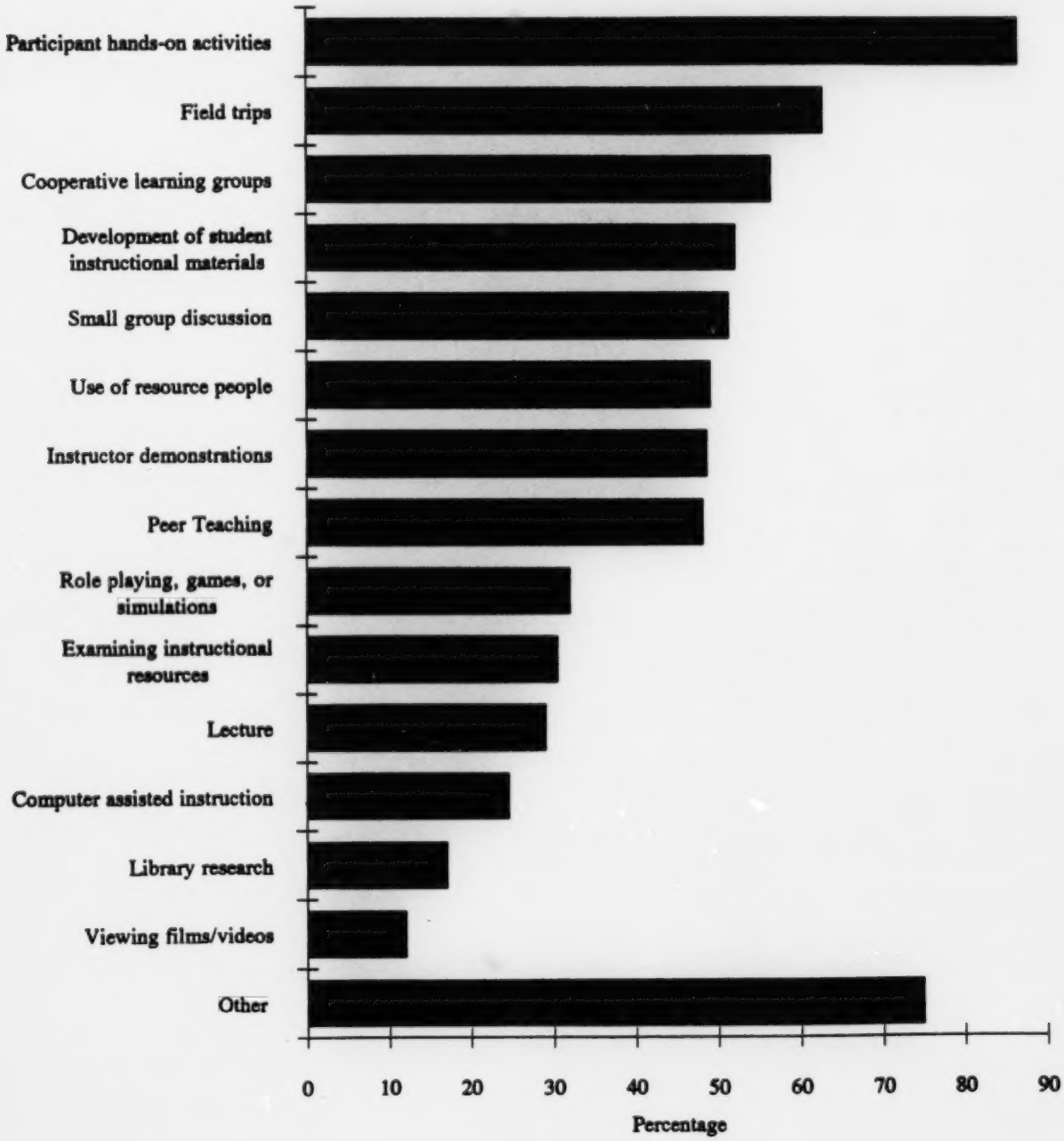
Source: PI Survey - Item 17

Figure 6B - Participant-Reported Instructional Methods and Materials Used in TEP Project



Source: Participant Survey - Item 6

Figure 7A - PI Assessments of the Usefulness of Various Teaching Methods and Materials (Percentage Reporting as "Very Effective")



Source: Item 17

important exception, however, was that lectures were seen as the most effective method for improving content knowledge levels. The assessments provided by the participants themselves (Figure 7B) show general correspondence to the PI's effectiveness assessments.

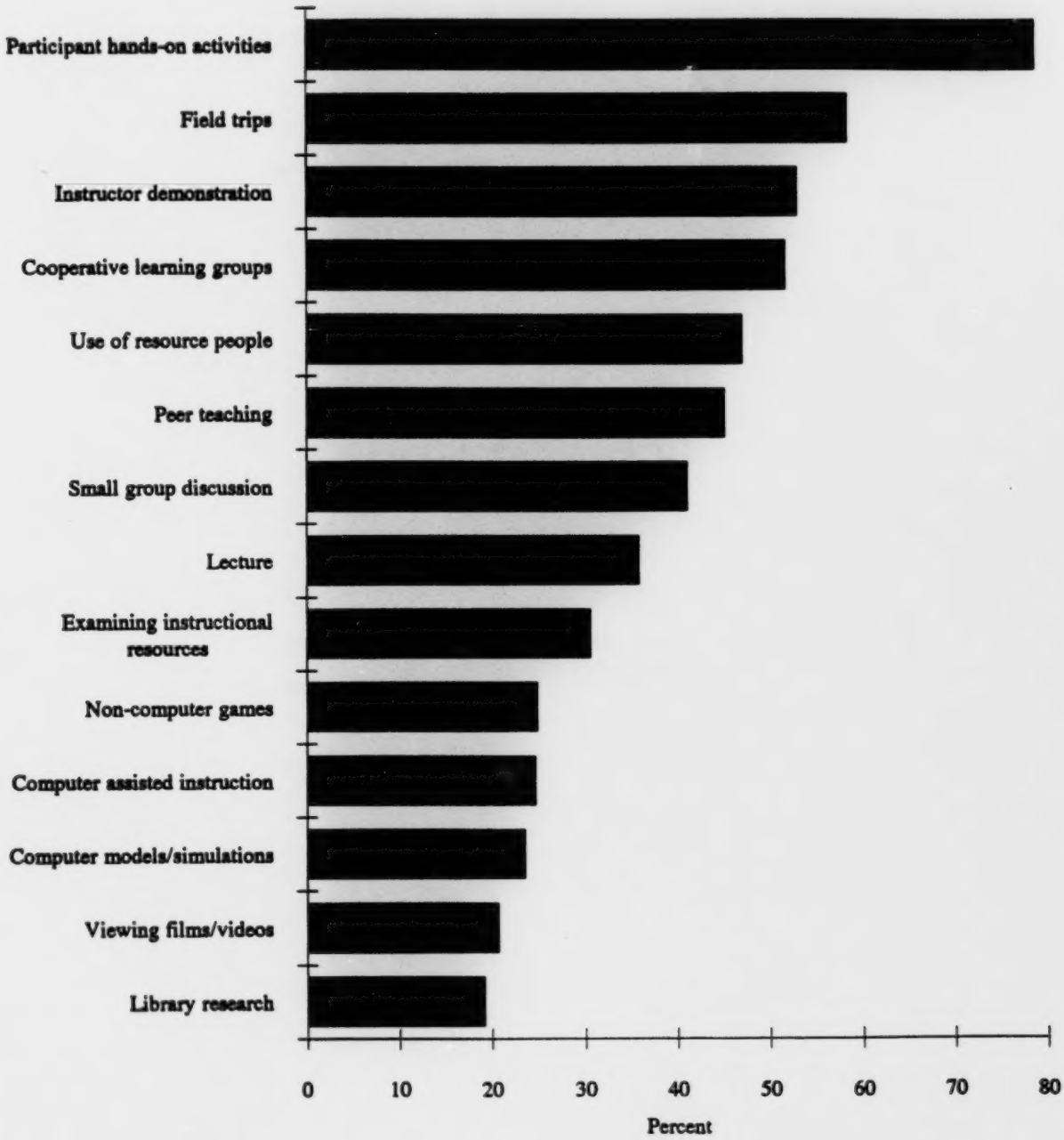
The PIs reported that their major project accomplishments included increasing participants' knowledge of science and mathematics, the subsequent use of new materials by participants in the classroom, and increased knowledge among participants of the applications of science and mathematics (see Figure 8A).

Participants were asked to rate their TEP projects on a broad range of criteria (see Figure 8B). Four in five would recommend the program to other teachers. Participant rating was similar to those of the PIs.

A critical concern is the extent to which changes occurred in teaching methods and contents among TEP participants upon return to the classroom. As shown in Figure 9, 80% of participants reported that, since TEP, they have provided students with more hands-on laboratory experiences, 75% had them work more in small groups, 71% integrated the applications of mathematics and science into their teaching more, and 69% helped students more to find answers to their own questions. Two other changes are also of note. Sixty-one percent conducted more scientific demonstrations for their students, and 52% use computers more in the classroom. In contrast, 35% of participants reported that they have decreased the amount of time spent lecturing to a whole class, and decreased the time that students spent reading textbooks in class. On average, about one-third of participants cited the TEP experience as an important contributing factor to the change.

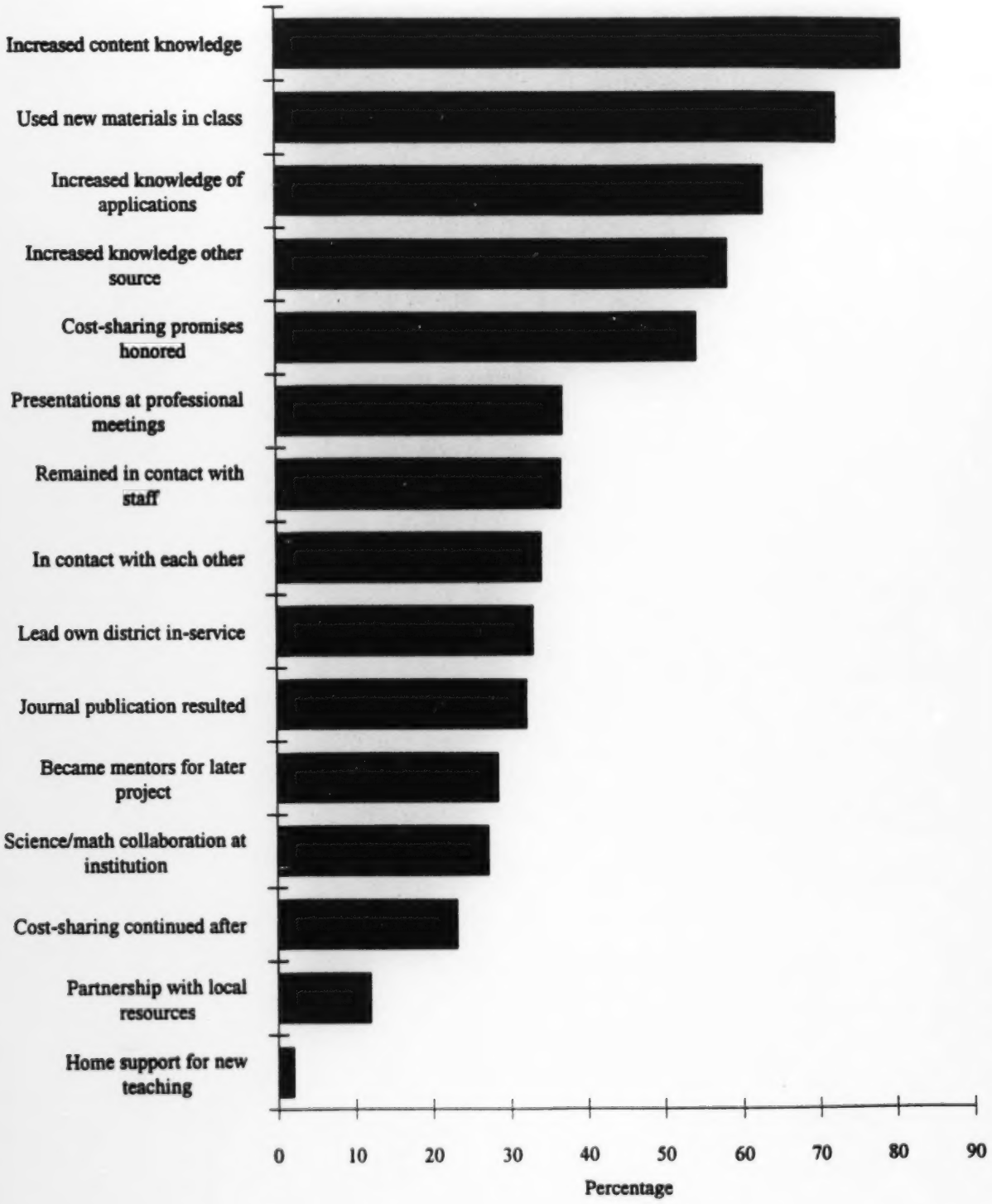
Participants were asked whether they believe the changes in their teaching have, in turn, been reflected in changes among their students. According to TEP participants' perceptions of such changes (see Figure 10), they have noticed increased student enthusiasm in class (80%), an increase in classroom test scores (52%), increased interest among students in careers in mathematics and science (49%), increased involvement in projects outside of class (43%), and increased participation in science fairs or contests (35%). Generally speaking, between one-half and two-thirds of the participants believed that their own TEP experience had had a major or relatively great impact upon the specific changes in student behaviors that they had observed.

Figure 7B - Participant Assessments of the Usefulness of Various Teaching Methods and Materials (Percentage Rating as "Very Effective")



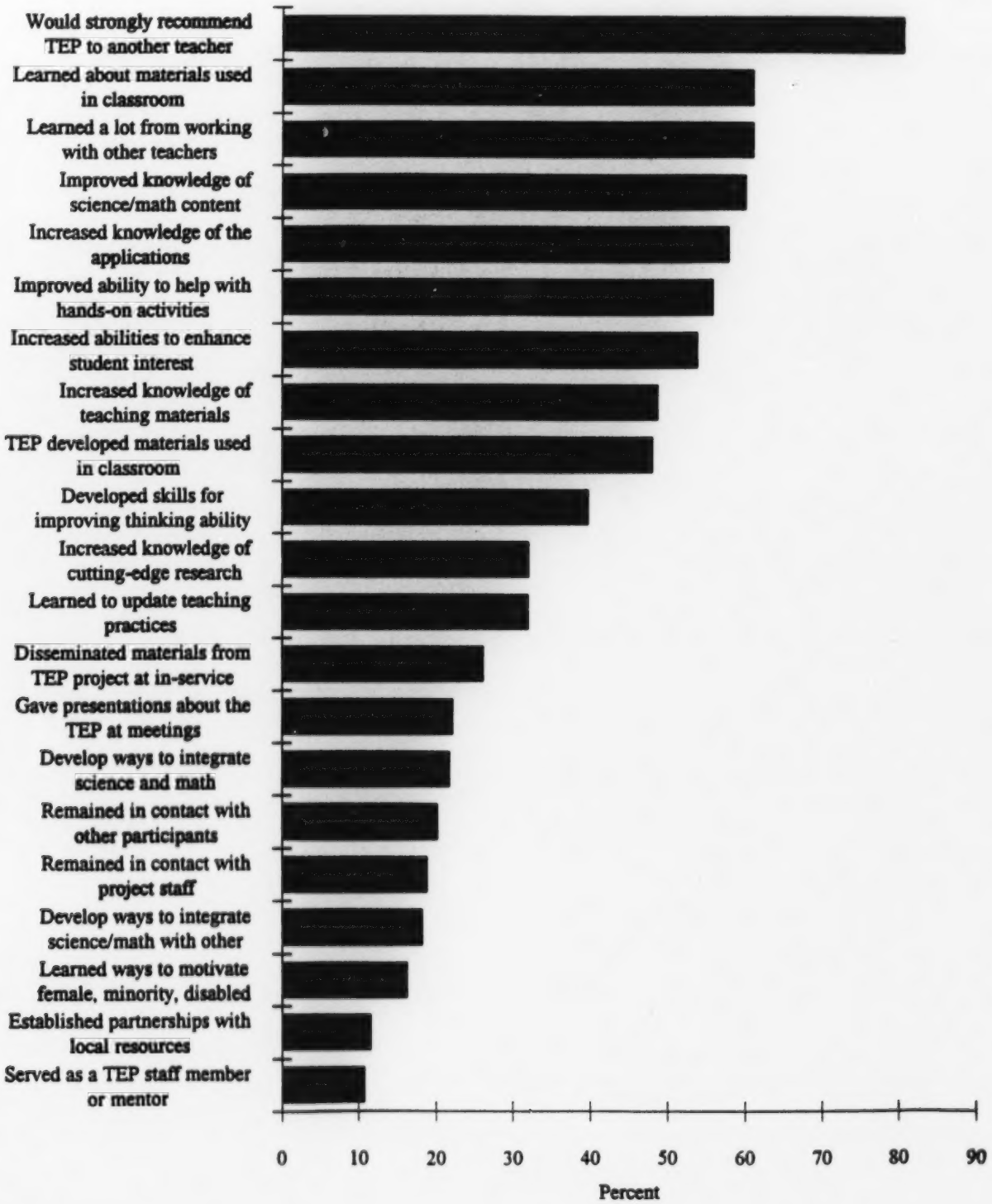
Source: Participant Survey - Item 6

Figure 8A - Principal Investigators' Assessments of Project Outcomes



Source: PI Survey - Item 22

Figure 8B - Participants' Assessments of Project Outcomes


Would strongly recommend TEP to another teacher
Learned about materials used in classroom
Learned a lot from working with other teachers
Improved knowledge of science/math content
Increased knowledge of the applications
Improved ability to help with hands-on activities
Increased abilities to enhance student interest
Increased knowledge of teaching materials
TEP developed materials used in classroom
Developed skills for improving thinking ability
Increased knowledge of cutting-edge research
Learned to update teaching practices
Disseminated materials from TEP project at in-service
Gave presentations about the TEP at meetings
Develop ways to integrate science and math
Remained in contact with other participants
Remained in contact with project staff
Develop ways to integrate science/math with other
Learned ways to motivate female, minority, disabled
Established partnerships with local resources
Served as a TEP staff member or mentor
0
10
20
30
40
50
60
70
80
90
Percent

Source: Participant Survey - Item 8

Figure 9 - Participants' Reports of Changes in Their Teaching Activities

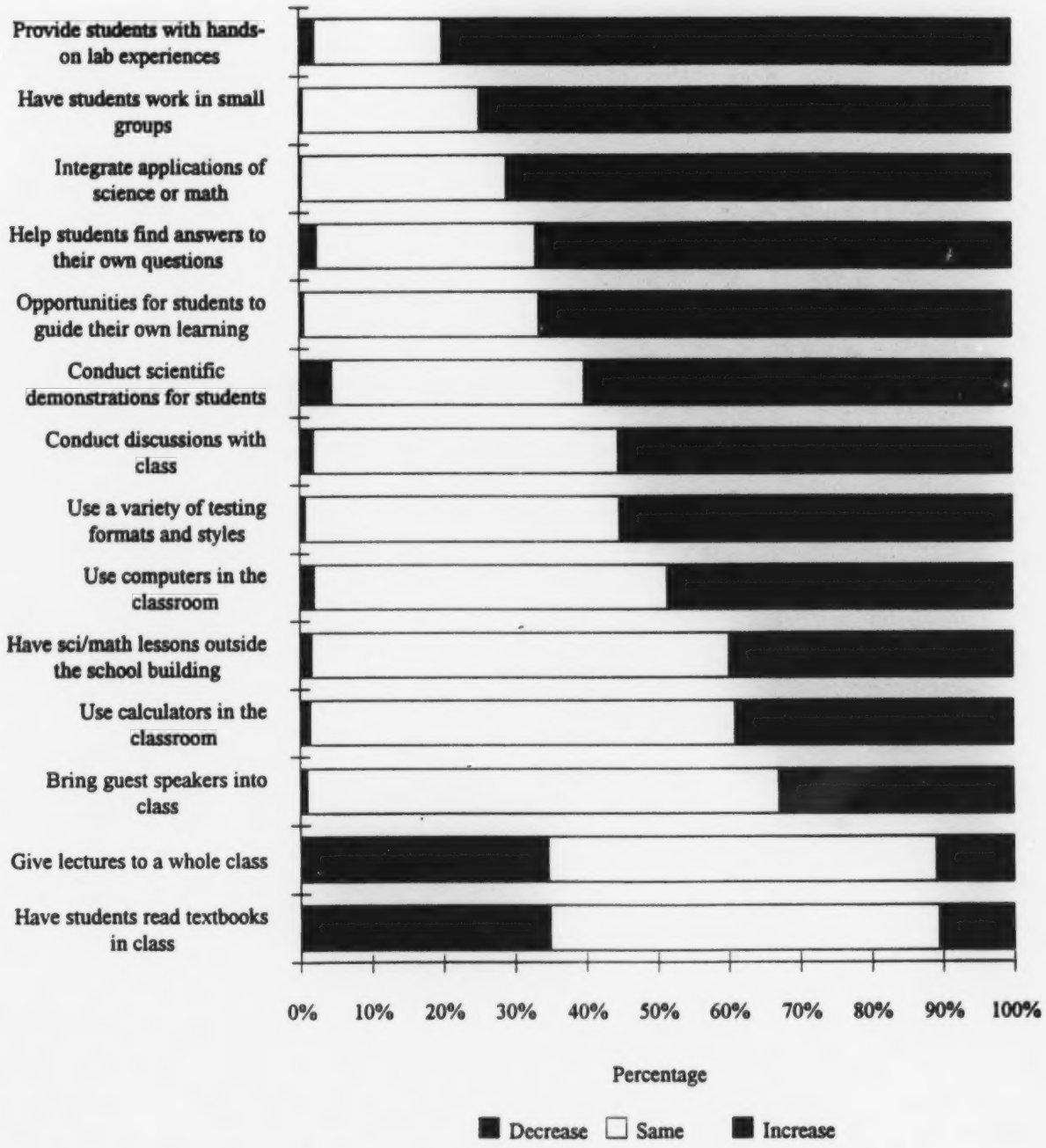
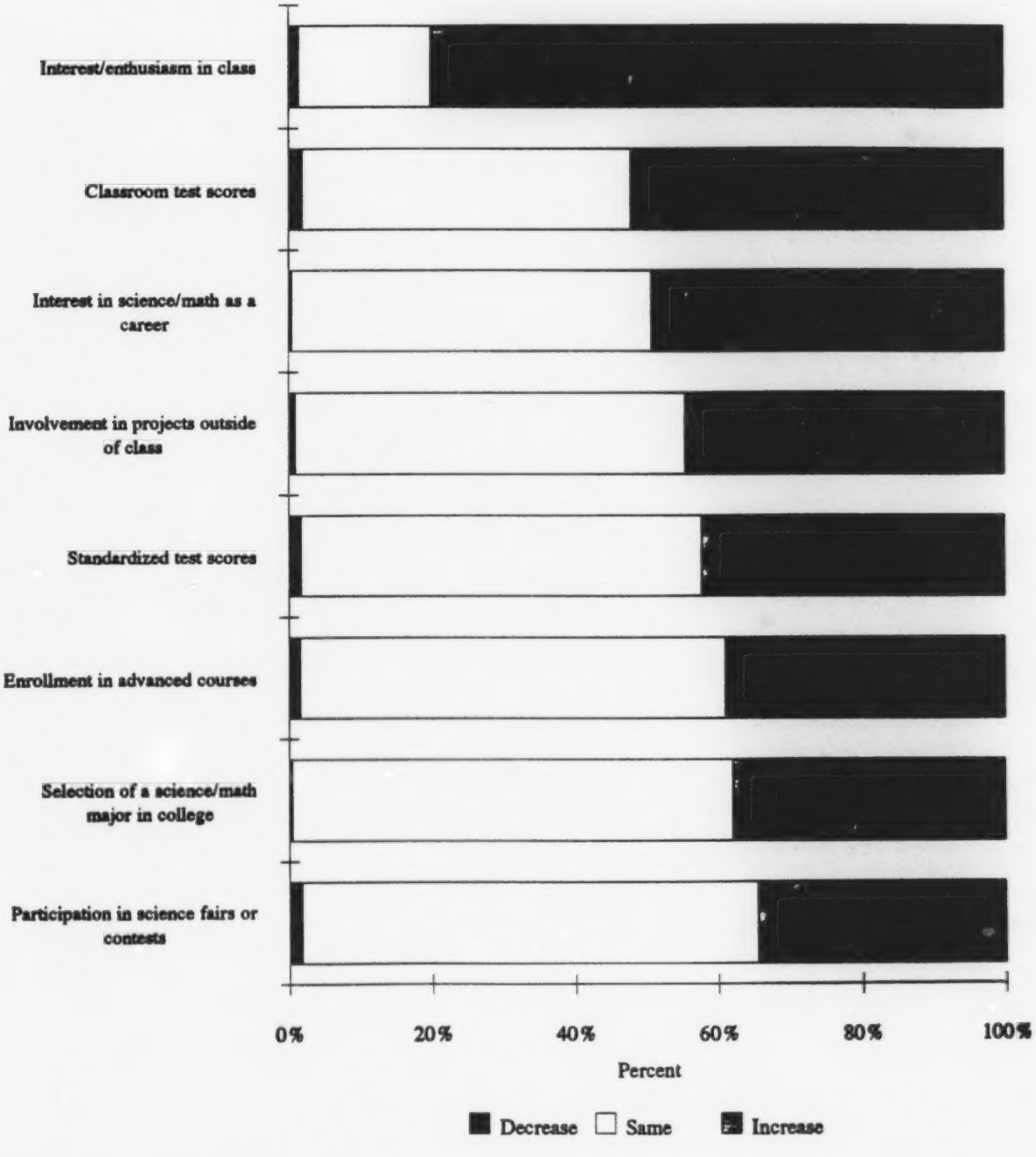


Figure 10 - Changes in Student Characteristics Since TEP Experience



Source: Participant Survey - Item 10B

Participants were also asked to indicate whether or not they had established working partnerships with other institutions. Across all years, 40% of participants reported that they had formed a working partnership with a scientific institutional resource. Among those reporting such partnerships, the most frequently identified types of institutional connections were with university science faculty (25%), university education faculty (17%), university faculty in mathematics or computer science (11%), and persons from private industry (11%).

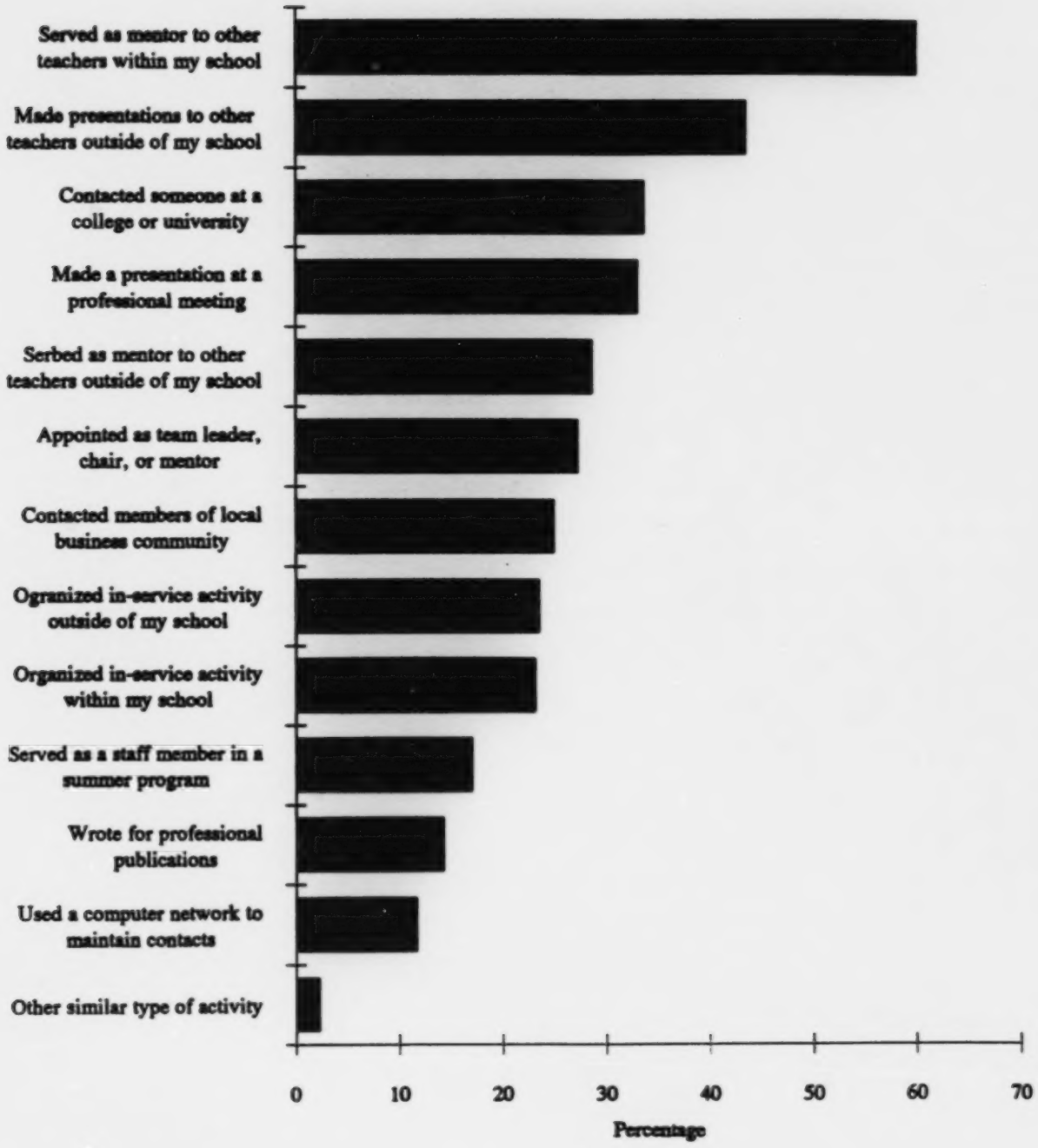
Participants reported on a variety of post-project professional activities (see Figure 11). The most common post-TEP post-project activities cited by participants were serving as a mentor to other teachers within their school (60%), making presentations to other teachers outside of their school (44%), and contacting someone at a college or university (34%). Many former TEP participants have been promoted to leadership positions: 47% of participants have been named mentor/master teachers, 41% have been named subject area department heads, and 25% have begun serving as science or mathematics curricula specialists since participating in TEP. Former TEP participants have also moved into leading administrative roles: 3.5% of TEP participants reported that they have been promoted to principal, and 8% reported that they are now performing other administrative roles in their school districts.

NSF strives to reach members of underrepresented groups through its many educational programs. Participants were asked to indicate their own race or ethnicity. Blacks (not of Hispanic origin) constituted 7.9% of all participants, while 3.3% were Hispanic, 2.2% were Asian or Pacific Islander, and 1.1% were American Indian or Alaskan Native. All of these percentages are slightly lower than the corresponding estimates provided by the PIs, who reported that an aggregate of 17.6% of all participants were minorities. More than half of all TEP participants were female. Roughly 3% of participants reported having some form of physical disability.

Financial Support

Over the entire six years studied here, the median value of an NSF award for a TEP project was $187,000. Significant growth occurred in award size over time, however, in 1984, the *median award* value was $77,000; this figure grew more than 300% to $309,000 by 1989. During the same period, the duration of a typical award increased from 24 to more than 30 months. Thus, the *median annual value* of the awards increased from $39,000 in 1984 to $124,000 by 1989 (by more than 200%).

Figure 11 - Participants' Reports of Post-Project Activities


Served as mentor to other teachers within my school
Made presentations to other teachers outside of my school
Contacted someone at a college or university
Made a presentation at a professional meeting
Serbed as mentor to other teachers outside of my school
Appointed as team leader, chair, or mentor
Contacted members of local business community
Ogranized in-service activity outside of my school
Organized in-service activity within my school
Served as a staff member in a summer program
Wrote for professional publications
Used a computer network to maintain contacts
Other similar type of activity
0
10
20
30
40
50
60
70
Percentage

Source: Participant Survey - Item 11

The PIs were able to achieve significant leverage on NSF funds; financial contributions from other sources amounted to $38.9 million (equal to 29% of NSF funds). "In-kind" contributions were reported with an imputed value of $32.9 million (equal to 23% of NSF funds). This constitutes a combined leverage among TEP projects of 52% of NSF funding. NSF's efforts under TEP to improve the quality of education are being significantly enhanced through this additional support provided by other science and educational institutions.

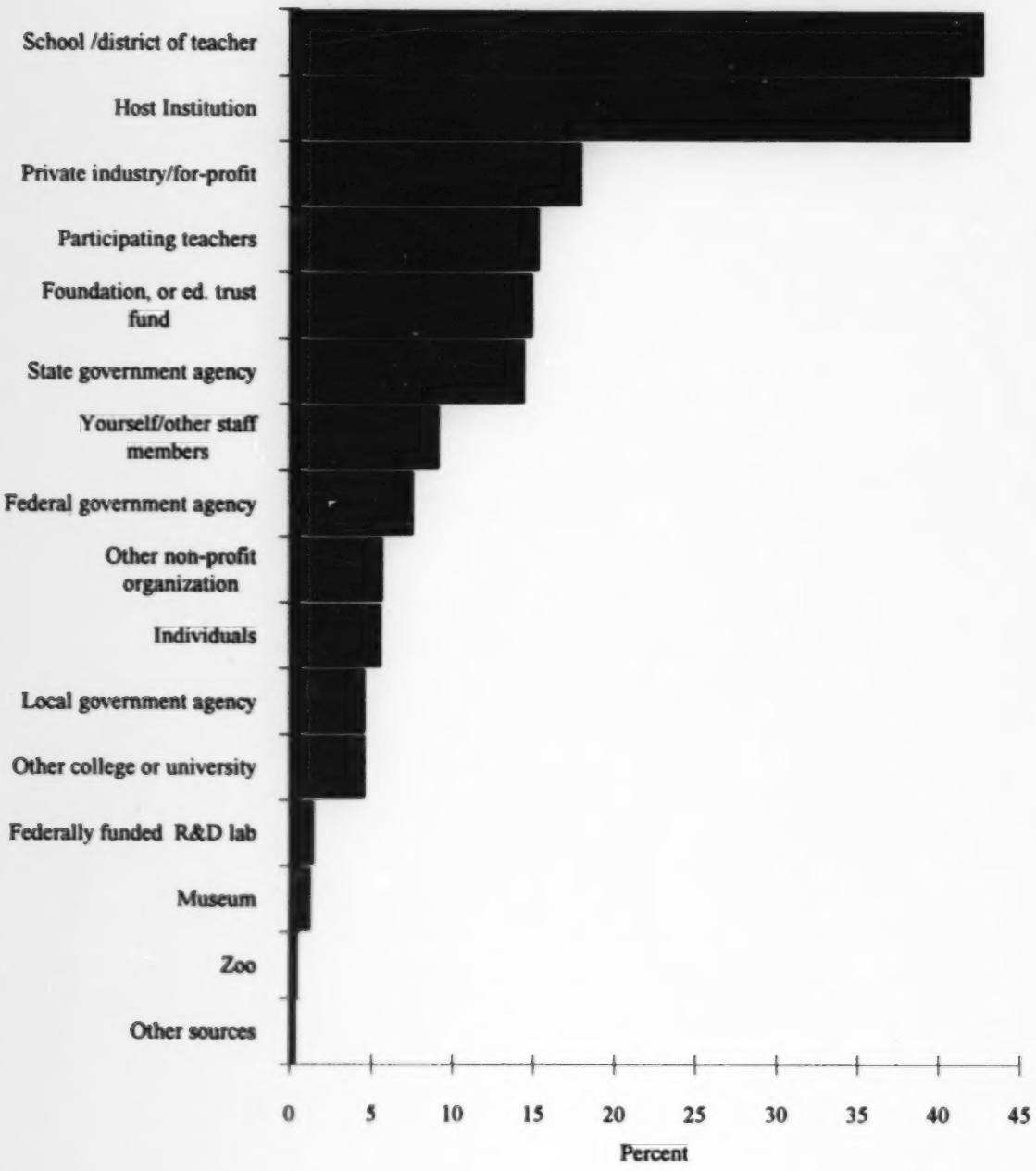
Taking into account this additional support, total annual expenditures almost doubled over the six year period -- from $82 thousand in 1984 to $162 thousand in 1989. It is important to note that the value of both direct financial support and in-kind contributions received by TEP projects has risen over time.

As shown in Figures 12 and 13, this additional support typically was provided by the host institutions of the TEP PIs, the school systems of the participants, foundations, private business and industry, various local institutions (e.g., museums), and other governmental organizations (including Federal R&D laboratories).

Characteristics of the TEP Participants

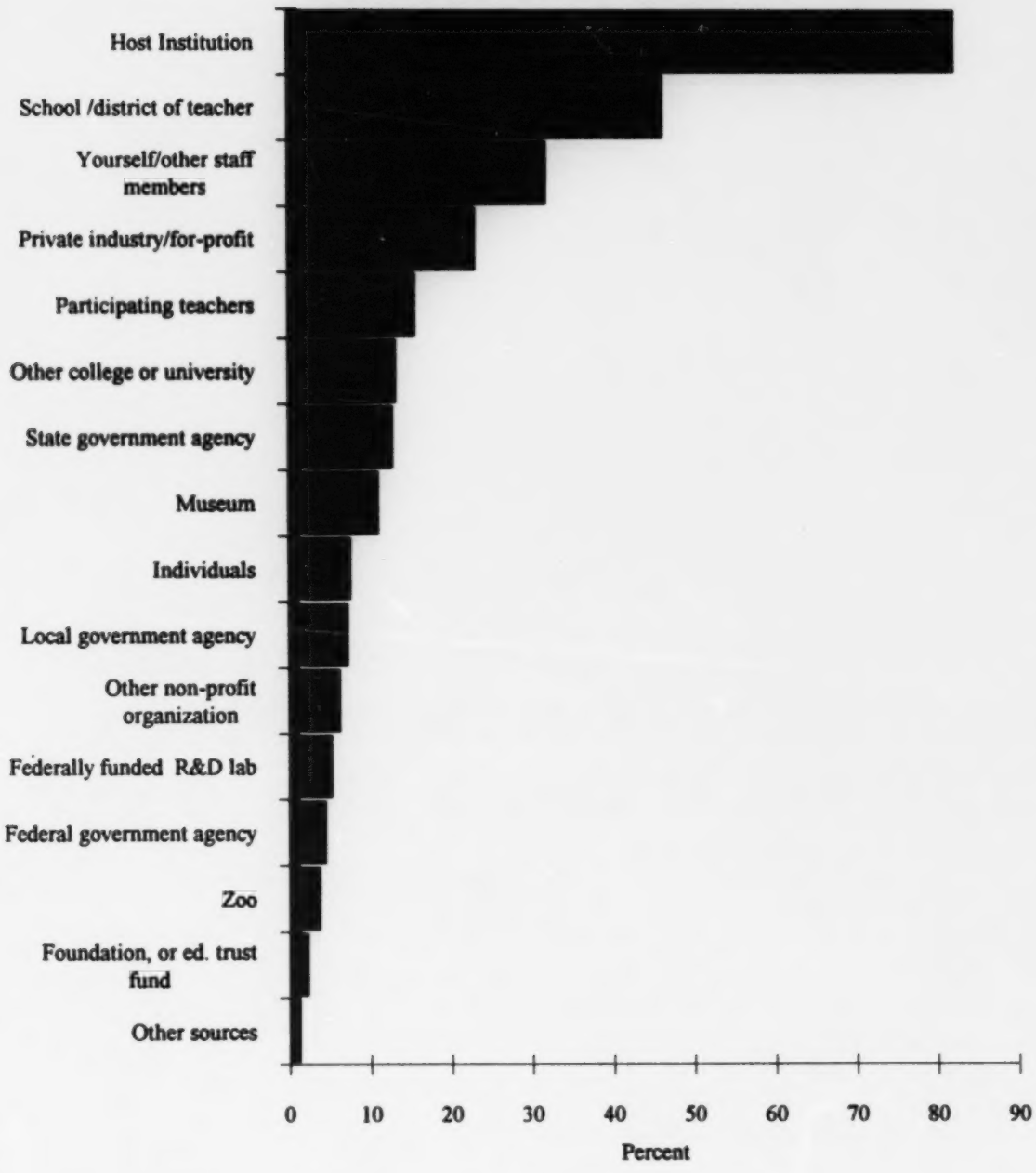
The PIs typically recruited teachers that they expected to become school leaders, of whom a roughly equal number were seen as being either under-prepared or well-prepared for their present teaching responsibilities. Additionally, female and minority participants, and participants from economically disadvantaged districts were sought (see Figure 14). Typically, PIs recruited teachers through announcements sent to local school districts, making contacts at local meetings of school professional staff, and sending information to local teacher organizations (see Figure 15). Over time, the emphasis placed on recruitment of women, minorities, and teachers working in economically disadvantaged areas increased. Participants reported on how they first learned about the TEP projects in which they participated. The most common sources of information about TEP for participants were their local school districts (49%), other teachers or principals (40%), and professional journals or newsletters (21%). Over time, the importance of local school districts as sources of information about TEP for prospective participants generally increased.

Figure 12 - Percentage of PIs Reporting Other Sources of Financial Support to NSF Sponsored TEP Projects, by Source



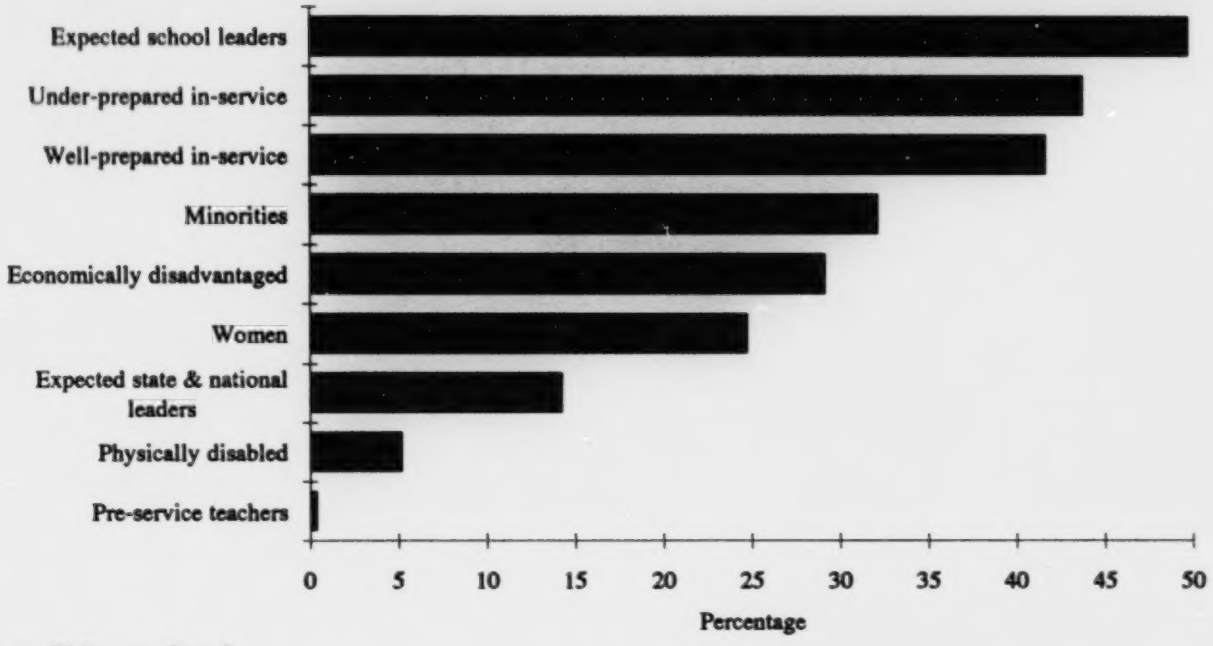
Source: PI Survey - Item 25

Figure 13 - Percentage of PIs Reporting Other Sources of In-Kind Support to NSF Sponsored TEP Projects, by Source



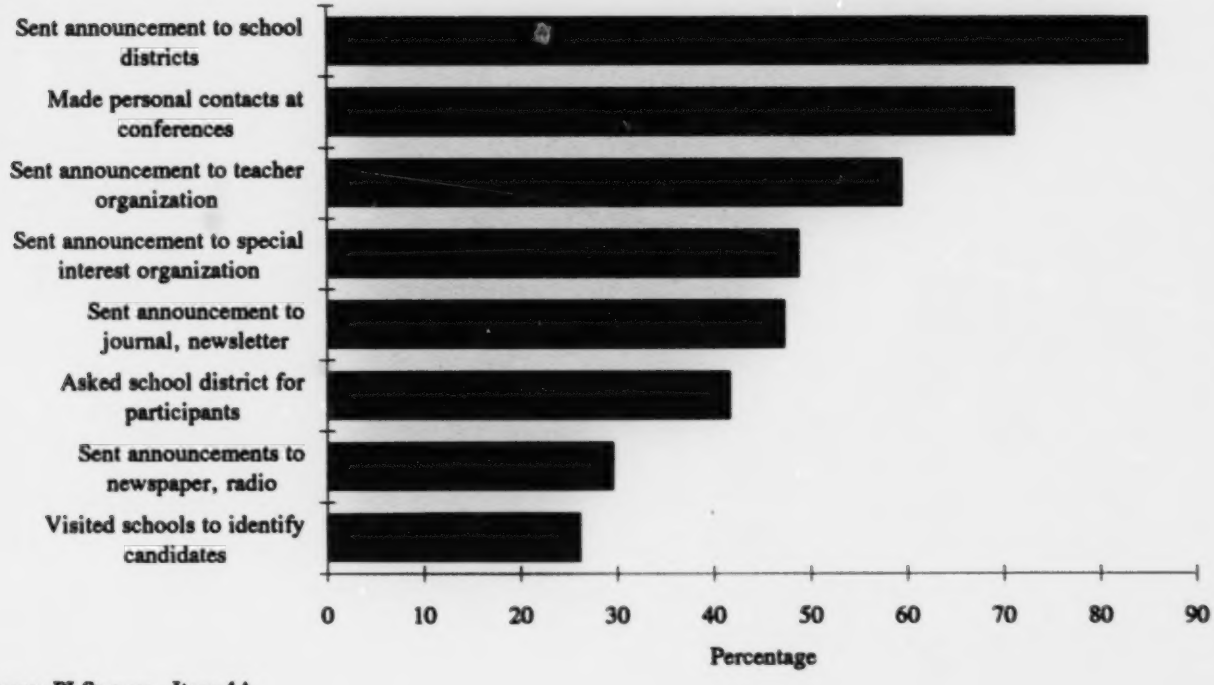
Source: PI Survey - Item 25

Figure 14 - Focus of Teacher Recruitment
(Percentage of PIs Rating Group as a Major Focus)



Source: PI Survey - Item 3

Figure 15 - Methods Used for General Recruitment



Source: PI Survey - Item 4A

PIs had provided estimates of the distribution of their project participants by grade level taught (see Figure 16). Participants also provided data on the level of school they taught (see Figure 17). The majority of participants (56%) reported teaching on the high school level, while just under 20% reported teaching respectively at the middle/junior high school level and at the elementary level. The remainder taught in Kindergarten. The figures provided by PIs varied somewhat from those provided by the participants (indicating somewhat lower high school and somewhat higher junior high school levels among their participants).

The great majority of all TEP participants (92%) are teachers in public school districts; the remaining 8% teach in private schools. Over time, the percentage of TEP participants from private schools has increased steadily from 5.5% in 1984 to 11.3% in 1990.

Participants were asked to indicate all degrees that they held; 53% of all participants hold a Bachelor of Arts/Sciences, 46% have a Masters Degree in Education, 27% have a Masters of Arts/Sciences, and 26% hold Bachelor degrees in Education. Over time, the distribution of degrees held by participants remained generally even although the percentage of participants with Bachelors in Arts/Sciences did increase from 49% in 1984 to 57% in 1990. In the opinion of PIs, the level of formal training in science or mathematics among the TEP participants varied directly as a function of grade level taught, with high school teachers possessing the most extensive undergraduate preparation in such fields.

Participants also specified, for the highest degree earned, both their major and minor fields of study. The most often cited major fields of study for participants were education (31%), the biological sciences (18%), science education (11%), and mathematics education (10%). The most common minor fields of study cited by TEP participants were education (19%), science education (14%), and chemistry (12%). Over time, the percentage of participants majoring in biological science dropped slightly while the percentage of participants earning their highest degrees in education increased.

The majority of participants (57%) considered themselves to be well-prepared in-service teachers, while 38% said that they expected to assume leadership roles in their school districts, and 20% described themselves as under-prepared in-service teachers. Over time, however, more participants characterized themselves as under-prepared in-service teachers and fewer participants characterized themselves as well-prepared.

Figure 16 - PI Report on Average Grade Level Taught by TEP Project Participants

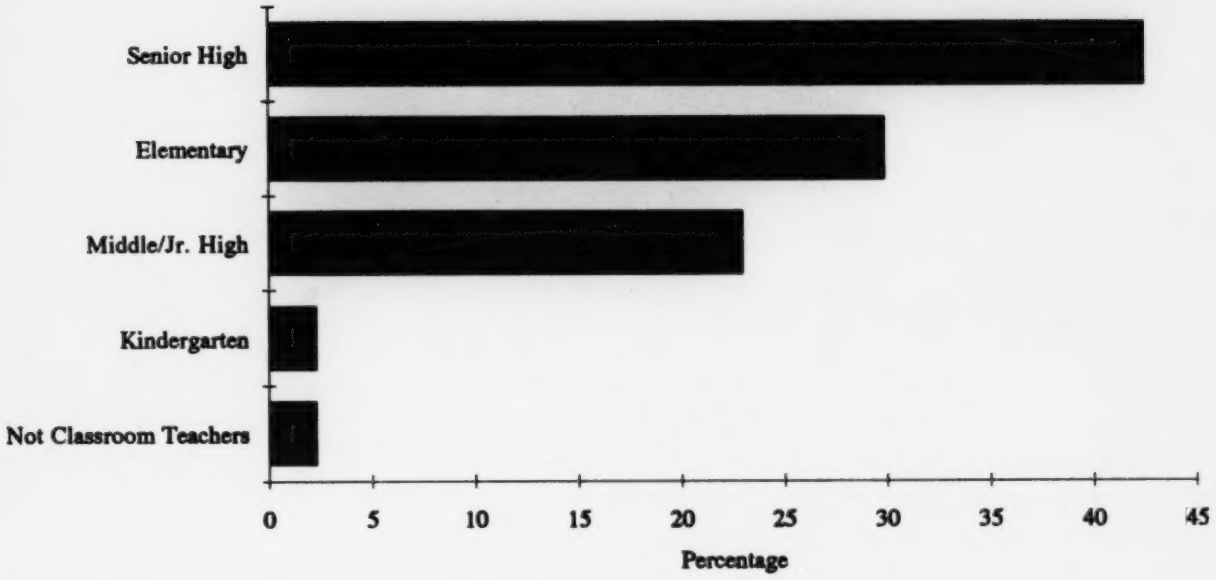
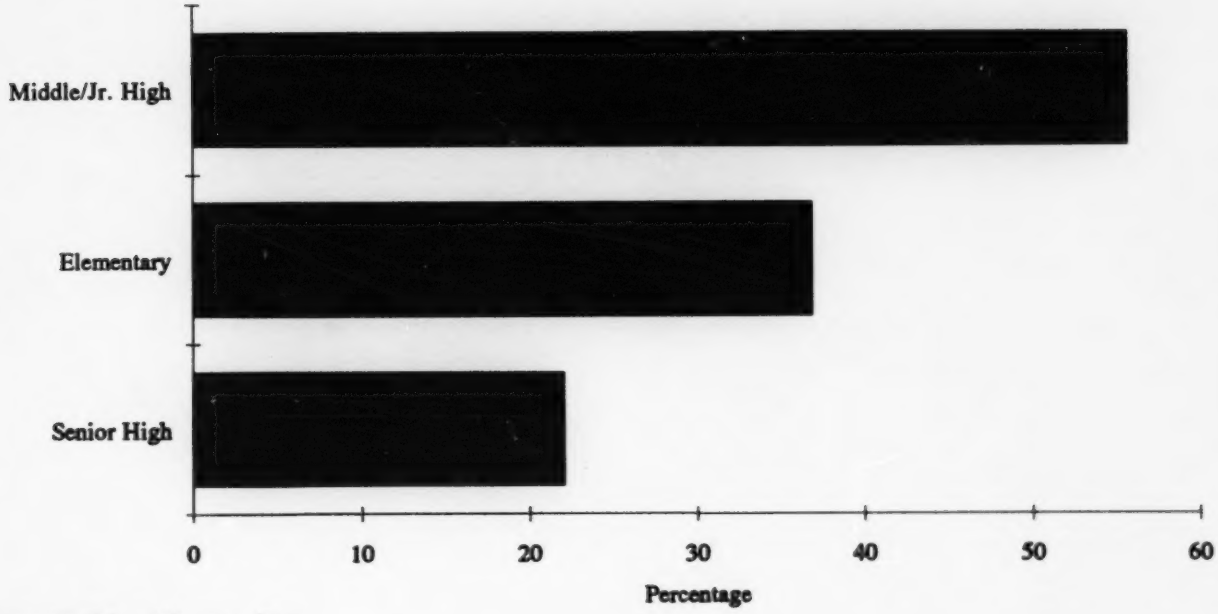


Figure 17 - Participants Report on Average Grade Level Taught by TEP Project Participants, by Award Cohort



Source: Participant Survey - Item

Relationships Among Project Characteristics and Outcomes

Various PI, TEP project, and participant characteristics were examined in order to determine whether significant associations existed. A variety of significant relationships were found. In this section, we examine first selected relationships identified among participants, and then turn to an examination of relationships among the PIs.[1]

Participants

TEP participants shared several major goals when they decided to join the project. Sixty percent or more of participants rated each of the following goals as "very important" (the highest scale rating available to them):

- Develop ways to enhance student interest
- Gain experience with hands-on activities
- Increase knowledge of applications of principles
- Improve knowledge of science/math content
- Develop additional teaching skills

Other goals, however, were less widely shared among participants. Overall, only 27% of teachers thought that learning to motivate female, minority, or disabled students was very important. Women gave this goal substantially higher importance than did men; one-third of the women thought it was very important, compared with one-fifth of the men.

Among teachers who were themselves members of a minority group, however, 58% rated this as a very important goal influencing them to participate in TEP, compared with 23% of non-minority teachers.

Both black and white teachers expressed support for this goal in direct relation to the number of minority children in the student bodies of the schools where they taught. More than half of the teachers in schools with predominately minority enrolment thought motivating these students was very important, while fewer than a quarter of those in schools with predominately non-minority enrolment thought so. Two other school attributes were also highly correlated with

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[1] *Relationships reported in this section were significant at the .001 level; see Volume II of this report for a more detailed discussion of these findings.*

response to this goal: urban school locations, and fraction of students eligible for free or subsidized lunches.

Teachers in poor, urban, or predominately minority schools, and teachers who were themselves members of minority groups, were much more strongly motivated by the prospect of developing the ability to mobilize other resources than were their wealthier counterparts. In schools where nearly all (over 75%) of the students met the eligibility criteria for free or reduced price lunches, 27% of the teachers thought that mobilizing resources was an important goal, while in schools with few such students, and in predominately white schools, only 10-13% thought so. Minority teachers were substantially more influenced by this goal (30% thought it very important) than white teachers (14%).

Teachers at different grade levels had substantially different motivational patterns for participation. Nearly half of the high school teachers thought that "[increasing] knowledge of cutting edge research" was a very important goal, while only a quarter of teachers of grades K-4 rated it this high. In contrast, 43% of the K-4 teachers thought that learning how to integrate science or math with other subjects was very important, while at the high school level only 16% of teachers thought so. Elementary teachers also attached higher importance to "gain[ing] experience with hands-on activities" and "develop[ing] ways to enhance student interest" than did high school teachers.

Teachers in rural schools differed from those in cities and suburbs in their goals for enhancing their personal credentials. Although no group gave very high ratings to earning continuing education or graduate degree credits, rural teachers' ratings of this issue were significantly higher than those of teachers in urban or suburban settings.

Teachers were asked to rate the project they attended on 8 specific and 1 general quality indicators. Most teachers rated their projects as excellent on most indicators, so these ratings did not reveal many detailed differences among teachers or project types. In addition, ratings on each specific rating item were highly correlated with the respondent's general rating of the overall quality of the program. Among the individual items, responsiveness of staff to participants stands out as most highly correlated with overall satisfaction.

Teacher ratings were influenced by the subject matter covered by the project, the grade levels targeted by project administrators, and the teachers' stated goals in attending the project. Other factors, such as the size and ethnic composition of the participating teacher population, and the scope of project recruitment, were not generally related to expressed teacher satisfaction on this item.

On most of the scales, projects which focused on either math or science instruction were rated higher than those which targeted both, or one where the subject matter could not be determined. Among projects which specifically targeted either math or science, those which also specifically targeted a narrow range of grade levels tended to receive higher satisfaction ratings than those which recruited teachers from all grade levels (or whose grade levels could not be determined).

This was especially true for lower elementary grade math teachers. Teachers of kindergarten through fourth grade students who attended math programs aimed specifically at their grade level were nearly unanimous in assessing the overall quality of their projects as excellent. Only 70% of similar teachers in projects with no discernible grade level focus gave this rating. Lower grade teachers in math projects with no specific grade focus gave particularly low ratings to "Knowledge of staff members about schools and teaching." Fewer than half of the lower grade participants in such projects thought their staff were excellent on this measure, compared with 90% of the lower grade teachers in grade-specific math projects.

A related pattern emerges for high school teachers. Those teachers attending TEP projects specifically focused on either math or science were not particularly sensitive to the grade level range of participants, often rating mixed grade programs as high as programs specifically aimed at high school teachers. When, the program addressed both science and math teachers, high school teachers generally gave higher ratings to programs which were specifically addressed to their grade level, as opposed to those with no discernible grade focus. The effects are not as strong as those for teachers of lower grade students, but are still statistically significant: 77% of high school teachers in single-level multi-subject projects rated the overall project quality as excellent, compared with 70% of high school teachers in projects with neither a specific grade focus nor specific subject content.

Teachers in upper elementary grades (5 through 8) resembled high school teachers in their preference for at least some focus on either a specific grade level or a specific content. When these teachers attended a project addressing both math and science, they uniformly gave higher ratings to grade-specific projects than to multi-grade projects.

These patterns are directly related to differences in goals between elementary, middle grade, and high school teachers. Elementary teachers place high value on goals representing instructional technique, and prefer TEP projects restricted to their grade level. In programs without a grade level restriction, elementary teachers specifically object to project staff's lack of familiarity with schools and teaching issues.

High school teachers place higher value on goals relating to substantive scientific or mathematical content. These goals seem to have been equally satisfied in all projects which had either a specific science focus or a specific math focus, but not in those which either had no identifiable content area or tried to address all content areas.

Patterns of participant ratings of specific results of their TEP participation resembled their overall quality ratings. Again, in general, ratings expressed a high degree of overall satisfaction: most teachers saw improvements in most of the areas covered by the survey. A principal components factor analysis suggested that the items in this scale fell into two broad classes, one relating to improved instructional skills and techniques for classroom use, the other relating to interactions between the participants and other teachers, project staff, or local institutions.

In both of these groups of items, early elementary teachers who attended math programs focused on their grade level tended to assign more positive ratings than early elementary teachers attending math programs with no clear grade level focus. High school science teachers likewise gave higher ratings to projects with a specific grade level focus which matched their teaching assignment. The nature and probable explanation of these patterns is essentially similar to that discussed above for general satisfaction with program quality and will not be discussed here in detail.

Responses to some of these items are related to the size and ethnic composition of project participant groups. Overall, ratings for items on the classroom techniques factor of the scale tended to be somewhat higher for middle-sized projects (40 to 100 participants) than for those which were larger or smaller. For example, 42% of teachers in middle-sized projects said it was very true that their TEP participation helped them "learn to update teaching practices,"

compared with about 32% of those in smaller or larger projects. Similarly 61% of those in middle-sized projects said it was very true that TEP had "increased [their] knowledge of sources or types of teaching materials," compared with about 51% of those in smaller or larger projects.

Ratings for networking objectives, such as remaining in contact with TEP project staff or other participants, tended to be slightly lower in the largest projects (those with over 100 participants) than in the small or middle-sized projects.

Projects with greater minority teacher participation (more than 10% of participants) tended to receive higher satisfaction ratings on the classroom techniques factors than those whose participants were nearly all white and non-Hispanic. No clear pattern is evident in the relationship between networking objectives and ethnic mix.

About a third of TEP participants reported that they had run into some barriers to applying the content or methods advocated by the TEP project they attended. Teachers in projects with local recruitment -- that is, teachers whose TEP institution was based in the same community where they taught -- were slightly less likely to report such barriers than teachers recruited from beyond the local area. In addition, teachers from projects with substantial minority representation (25% or more) were slightly more likely to report such barriers than were teachers in other projects.

Minority teachers, however, were no more likely than others to report encountering barriers to implementation. Teachers (of any ethnicity) in schools where a majority of children qualified for reduced price lunches were slightly more likely to report barriers to implementation than were teachers in schools with fewer than 25% of the children so situated. This is consistent with the fact that almost 60% of the teachers who reported a barrier mentioned lack of funds, supplies, or materials as the source of the problem.

Experienced teachers were much less likely to report barriers than those who had just begun teaching. Forty-two percent of teachers with five years experience or less reported at least one barrier, compared with 17% of those with over 35 years of experience.

Principal Investigators

A number of significant associations were found with respect to PI responses to their survey. First, *the goals that a PI had for his or her TEP project were associated with the choice of instructional methods and materials used.* As illustrations:

- The PIs who emphasized **subject matter objectives** used more **formal teaching methods**. Those PIs seeking to enhance teachers' knowledge of science and mathematics often used lectures; similarly, those interested in integrating science and mathematics knowledge often made use of computer-assisted instruction methods and field trips;

- PIs who emphasized **pedagogic objectives** used more **process-oriented teaching methods**. Those PIs who emphasized the updating of participants' teaching practices, or the improvement of participants' abilities to enhance their students' interest in science and mathematics or their students' problem-solving skills, often used such teaching methods as cooperative learning, role play, simulations and games.

Related to this, one factor beyond project goals was associated with the instruction method chosen: those PIs working with high school teachers were more likely to use lectures, while those working with elementary school teachers emphasized more process-intensive instructional methods.

Second, *a PI's TEP project goals also were influenced by whether or not he or she developed instructional materials*. For example, those PIs with pedagogic goals had higher participant involvement in the development of instructional materials, involved the TEP project staff in this process, and were more likely to use outside experts in the process as well.

Third, *a project's outcomes were associated with the instruction methods used and with the development of curriculum materials in the TEP project*. Lecture methods, according to PIs, were associated with an increase in participants' subject matter knowledge. Computer-assisted instruction, field trips, library research, use of films and videos, and examination of instructional materials also were associated with the PIs' assessments of increases in participants' knowledge of content and teaching materials.

On the other hand, more process-oriented methods, such as role playing, games, and simulations, were more likely to receive higher PI ratings of participant satisfaction with the TEP experience on a variety of other measures. As illustrations: more process-oriented methods (such as the use of cooperative learning groups) were associated with the maintenance of longer-term contacts between PIs and participants; the development and dissemination of new materials in the TEP projects was associated with the maintenance of longer-term contact with the PI, with the use of materials in the participants' school districts, and with the subsequent presentation of these materials at professional conferences. Where outside experts were involved in materials development, the materials were more likely to be disseminated to the schools.

Fourth, *the level of project budget, and the extent of non-NSF financial support, were associated with the choice of instructional methods*. PIs with smaller budgets were more likely to use lecture methods, less likely to use new materials and, as a result, the participants were less likely to use TEP project materials in their classrooms. On the other hand, those PIs with larger budgets were more likely to use more process-intensive methods, to make greater use of other project staff, and to develop instructional materials.

Institutional financial and other support were also associated with certain project characteristics. Funding support from sources other than NSF was associated with the use of computer-assisted instruction, instructor demonstrations, and participant experiences with hands-on activities. Host institution support was also associated with use of small group discussions and cooperative learning groups, examination of instructional materials, development of new instructional materials (and the involvement of participants in this process), and participant contacts with outside resources. Where there was lower external support, PIs were more likely to use role play, simulations, and games and to make use of peer teaching.

Fifth, *support from host institutions was associated with various perceived benefits to participants*, such as increased participant knowledge of science or mathematics content, familiarity with instructional materials, dissemination of project materials, subsequent participant return to TEP projects in staff positions, journal articles by PIs about their TEP projects, and more continuing collaboration between participants and the host institution.

Sixth, *a PI's ethnicity and physical disability status were associated with project participation and impact characteristics*. White, non-Hispanic PIs were significantly less likely to achieve high minority participation in their TEP projects than minority PIs. Fifty-eight percent of all Black participants were located in projects with Black PIs. In projects with Hispanic PIs, 38% of all participants were also Hispanic. Similarly, PIs with physical disabilities limiting a major life activity were most likely to recruit participants with such disabilities; they were also somewhat more likely than PIs without disabilities to attract minority participants.

Notably, minority PIs were more likely to report outcomes related to networking with other sources of science information and support. PIs with high Black participation were twice as likely as PIs with low minority participation to report both working with colleges, museums, etc., and increased collaboration between scientists and mathematicians and educational specialists at host institutions.

Seventh, *other PI characteristics appeared to have little to do with the selection of project methods and materials, or with TEP project impacts*. Departmental affiliation, educational background (subject and level of highest earned degree), tenure status, age, ethnicity, gender, and experience with prior TEP awards were **not related** systematically to most participant outcomes.

Finally, *certain other project characteristics were associated with participation patterns*. PIs who recruited locally were more likely to have high minority participation; general recruiting methods (e.g., announcements) were less likely to attract minority participants than non-minorities. Conversely, where PIs made special efforts to recruit participants in minority schools, they were successful in attracting them.

The distance between a participant's home and the location of the TEP project were associated with female participation rates; females were far less likely to participate in a project outside of their locality. Participants' conflicts with family responsibilities were cited as a chief factor by PIs for failure to achieve female recruitment goals in projects that drew participants from large geographic areas.

Participant and PIs' Observations About Their TEP Experiences

Principal Investigators and participants were provided with an "open-ended" opportunity to present various project, program, and policy ideas they had regarding the Teacher Enhancement Program. The following summarizes their observations.

- Making *use of "hands-on" learning techniques* was a common theme -- cited by PIs frequently as an important lesson learned, and by both PIs and Participants as one of the "best models" for in-service training, and as an important change to be made in future projects (where it had previously not been sufficiently utilized);

- A greater focus on the *involvement of participants in project operations* was also considered important by PIs and participants alike -- involving participants in the planning and setting of project goals, the use of teacher pairs and groups, and greater involvement of participants in the learning process;

- An extremely important lesson learned, according to PIs, was the need for obtaining *more commitment from school districts*;

- Many PIs and participants emphasized the need for more *follow-up activities to reinforce the in-service experience* -- more follow-up and support of

participants, the formation of participant networks, and the continuing involvement of participants;

- A very important accomplishment identified by PIs and participants related to *the participants' teaching of science and mathematics* -- upgrading participants' teaching practices, and improving their substantive knowledge;

- The *development of leadership capabilities* was another second key theme among both groups -- enhancing the self-confidence of participants, focusing on leadership development, and using exemplary teachers to teach other teachers;

- Many PIs and participants took the opportunity to *compliment NSF on an outstanding program* and to comment on the high quality of NSF staff involved in its operation;

- A dominant theme among PIs was *the need for greater lead time between notification of awards and project initiation* -- many PIs believed that NSF should require earlier grant application submission in order to achieve a more appropriate award notification schedule;

- The issue of more *direct support to PIs by NSF staff* was an important theme -- including the need for greater availability of NSF staff to PIs, and better communications with PIs, including the sharing of ideas on how best to operate in-service programs; and

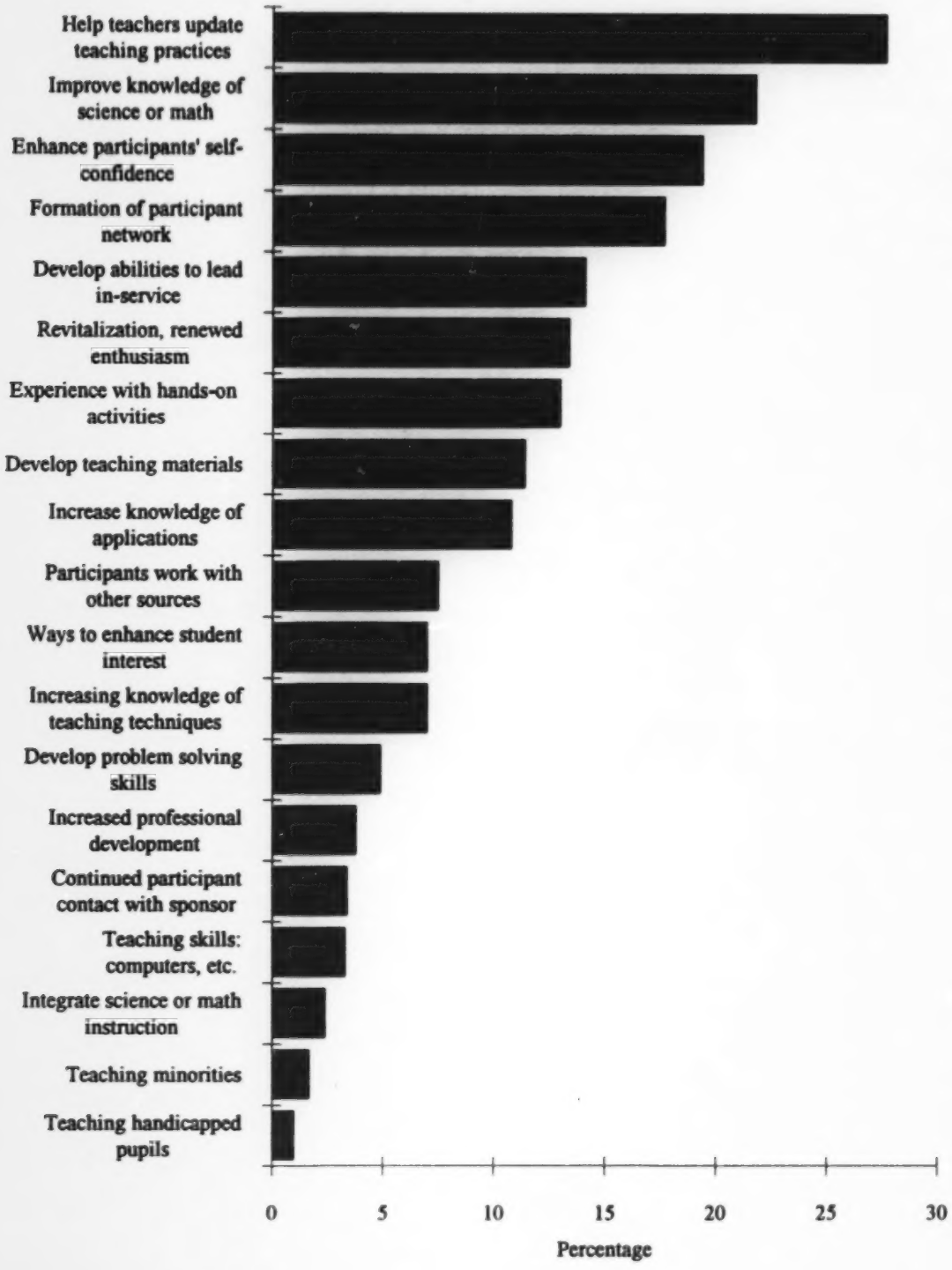
- Many PIs felt the need for *follow-up funding of successful TEP projects* -- extending the period from three to five years.

PIs and participants provided greater detail on significant project accomplishments, lessons that they learned, most promising TEP models, changes they would make if running their projects again, and so forth.

- The PIs most frequently mentioned, as significant impacts of their projects upon participants, the updating of teaching practices and improving subject area knowledge of participants, enhancement of participants' self-confidence, and formation of participant networks (see Figure 18).

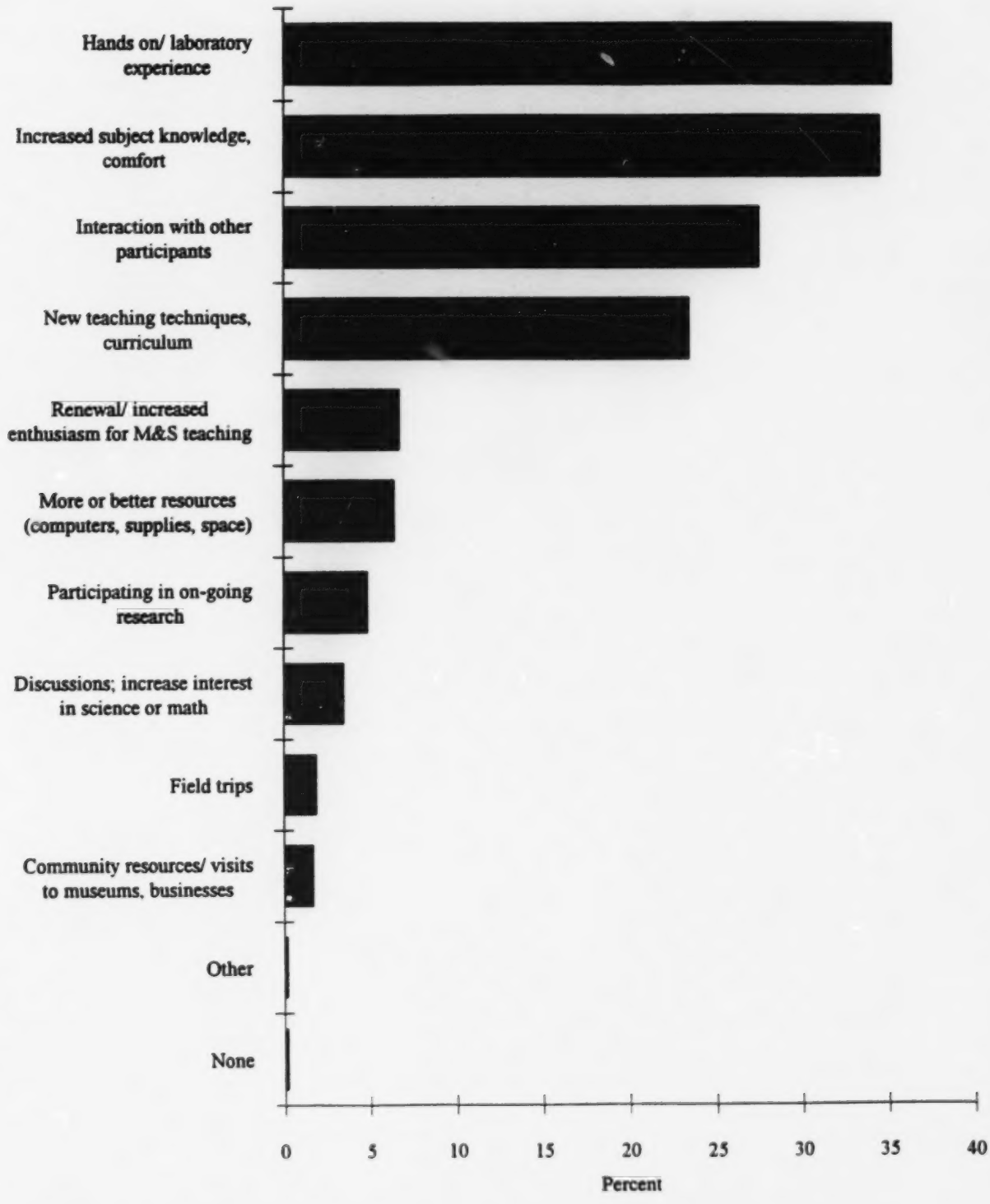
- Participants felt that the aspects of their TEP projects having the greatest value involved the experience with hands-on/laboratory techniques, increases in their knowledge and comfort with the subject matter, interaction with other participants, and new teaching techniques and curricula (see Figure 19).

Figure 18 - Principal Investigators' Reports Upon Specific Significant Project Accomplishments, by Type Accomplishment



Source: PI Survey - Item 40a

Figure 19 - Participants' Views of Greatest Impacts of Projects



Source: Pariticipant Survey - Item 46a

- The need to obtain more commitment from participants' school districts, and the need for a hands-on approach were the most frequently cited "lessons learned" by PIs about running the TEP projects(see Figure 20).

- Participants rated the greatest benefits of TEP project participation for their students as students increased their knowledge and confidence in subject matter; obtained greater experience with improved demonstration, manipulatives and hands-on activities; increased their interest in science or math, and their exposure to new teaching methods (see Figure 21).

- According to PIs, the most promising TEP models included the use of role models (top teachers teaching other teachers), the use of hands-on methods, and the use of teacher pairs or groups to enhance learning (see Figure 22).

- Participants also identified various specific models, and favored hands-on and cooperative learning groups as models (see Figure 23).

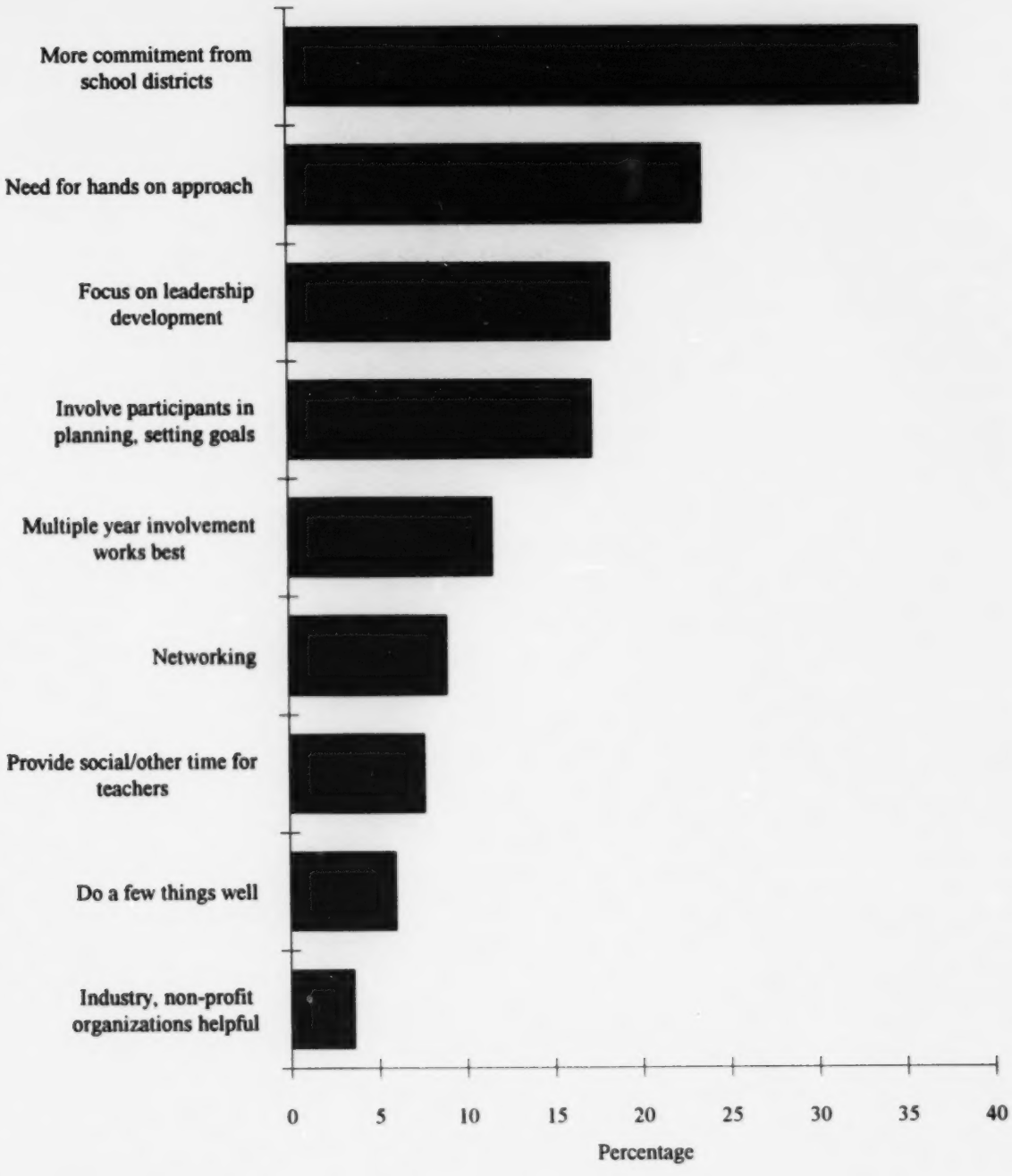
- Were PIs to run another TEP project, lessons to be implemented included continuing involvement of participants, more follow-up support for participants, more hands-on activities, more extensive recruitment activity, more pre-project planning, and making a greater effort to influence the school districts and other local organizations (see Figure 24).

- Many participants were satisfied with their TEP projects as is. Those suggesting changes suggested ones related to course content, solicitation of more inputs from participants by PIs, use of more field trips, and more program follow-up by PIs (see Figure 25).

- PIs would like to see NSF provide more lead time for the start-up phase of their projects, have more communication with PIs, provide more funding, and provide better access to NSF support staff (see Figure 26).

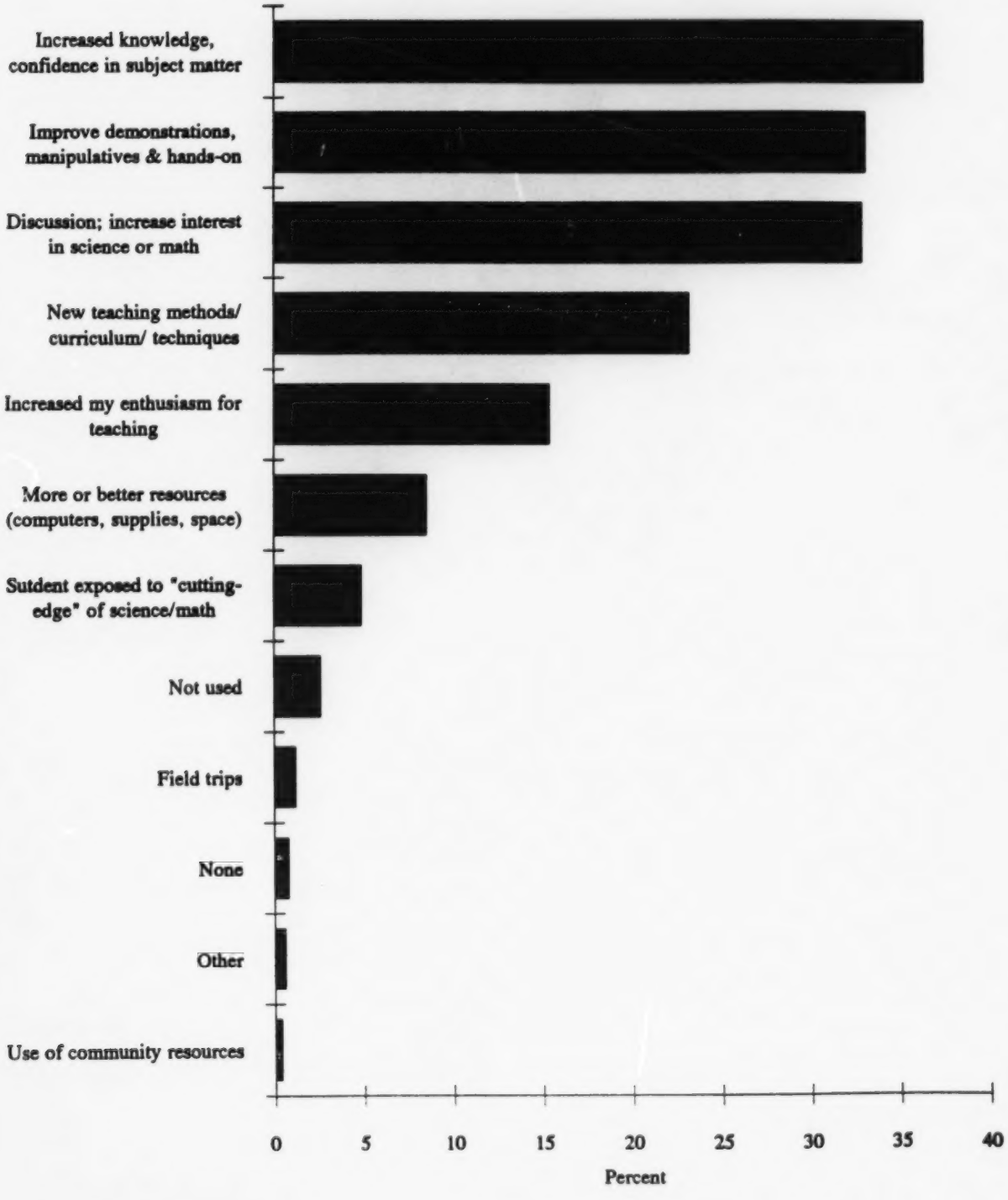
- Participants also suggested that NSF might increase funding for TEP projects, that the projects provide more effective outreach and recruiting, and that PIs have more regular follow-up with participants (see Figure 27).

Figure 20 - Principal Investigators' Reports of Specific Lessons Learned



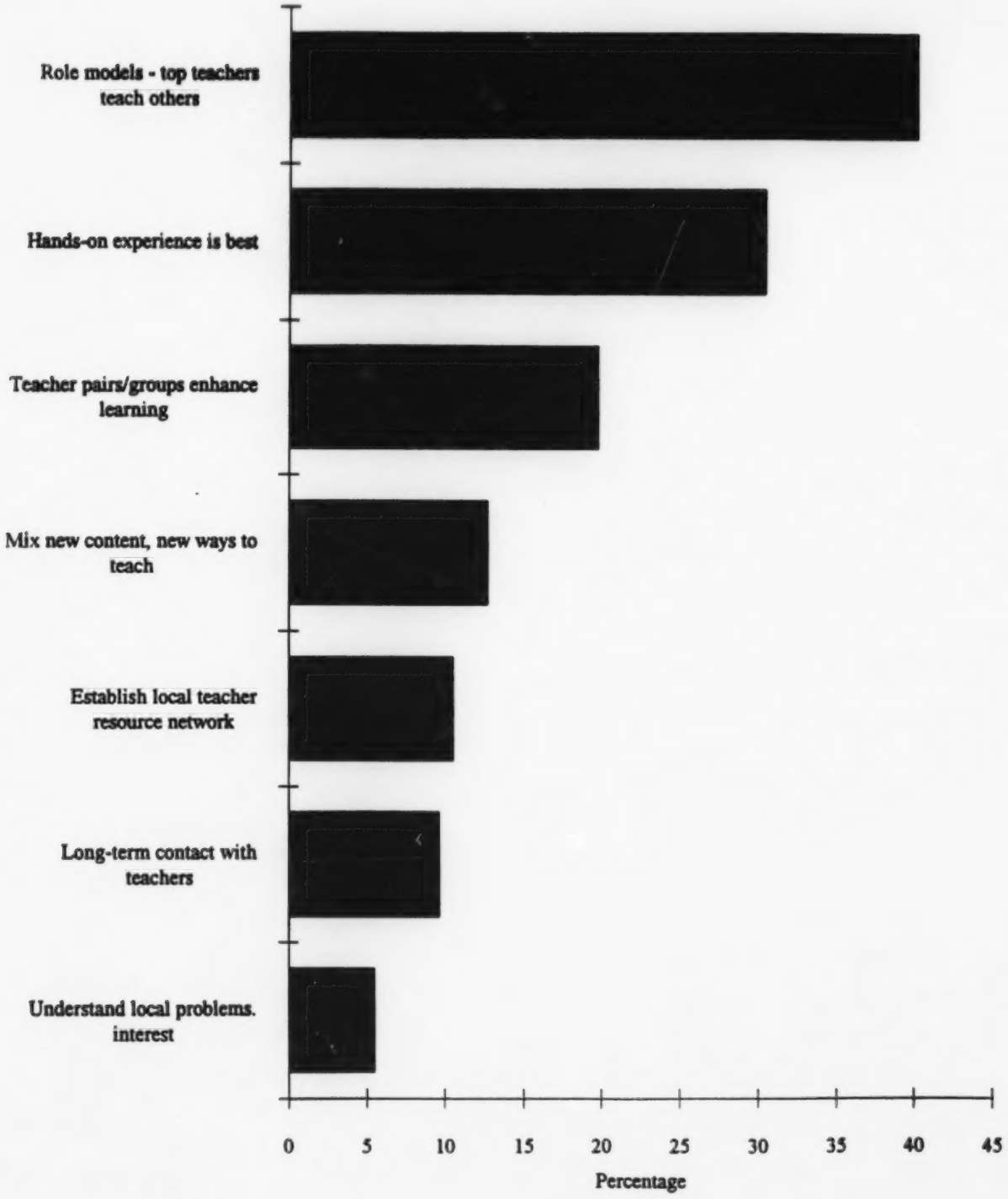
Source: PI Survey - Item 40b

Figure 21 - Participants' Reports on Benefits to Their Students



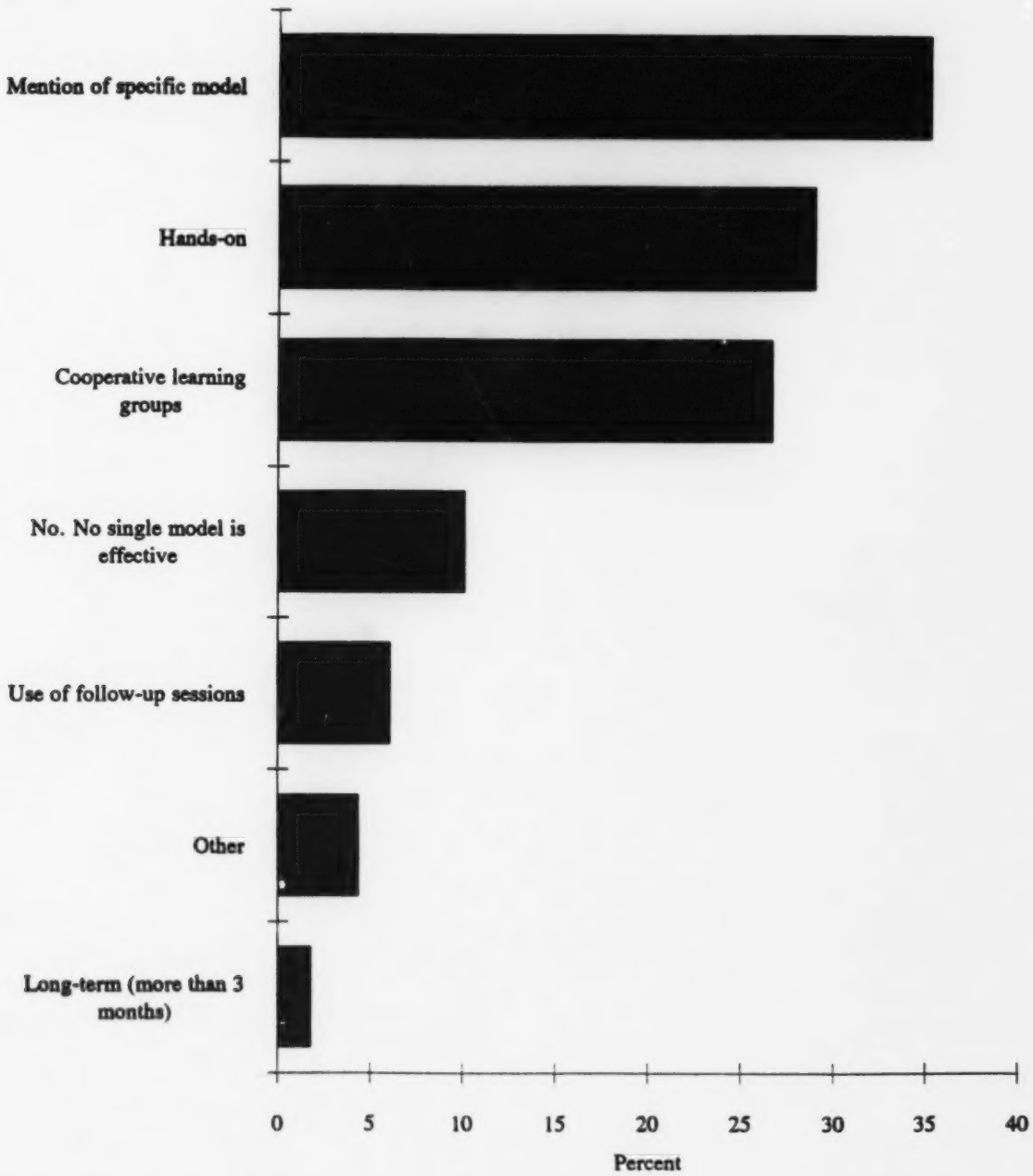
Source: Participant Survey - Item 46b

Figure 22 - Principal Investigators' Reports of Particular Model with Greatest Promise for Enhancing Teacher Skills



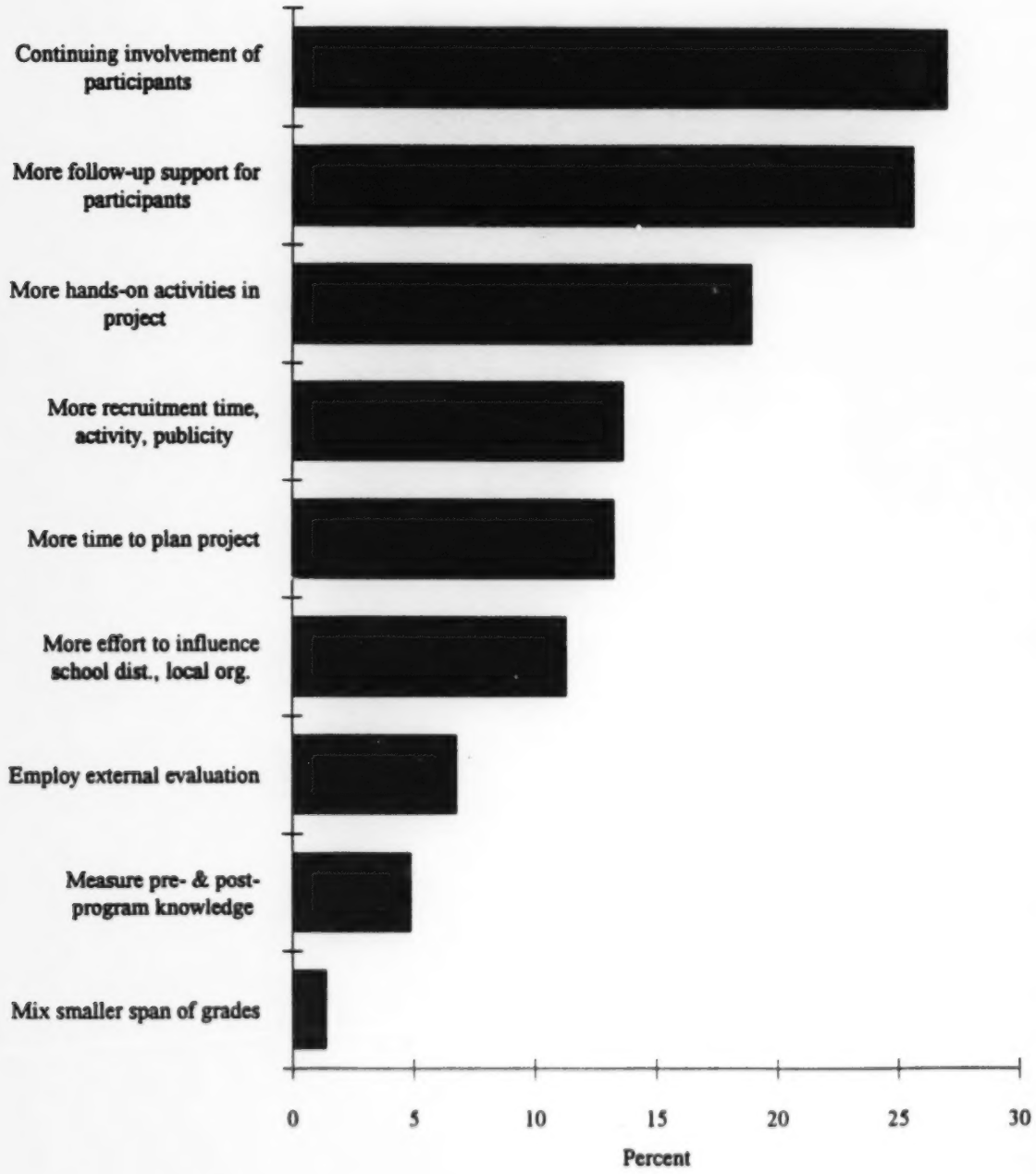
Source: PI Survey - Item 40c

Figure 23 - Participants' Reports of a Particular Model with Greatest Promise for Enhancing Teacher Skills



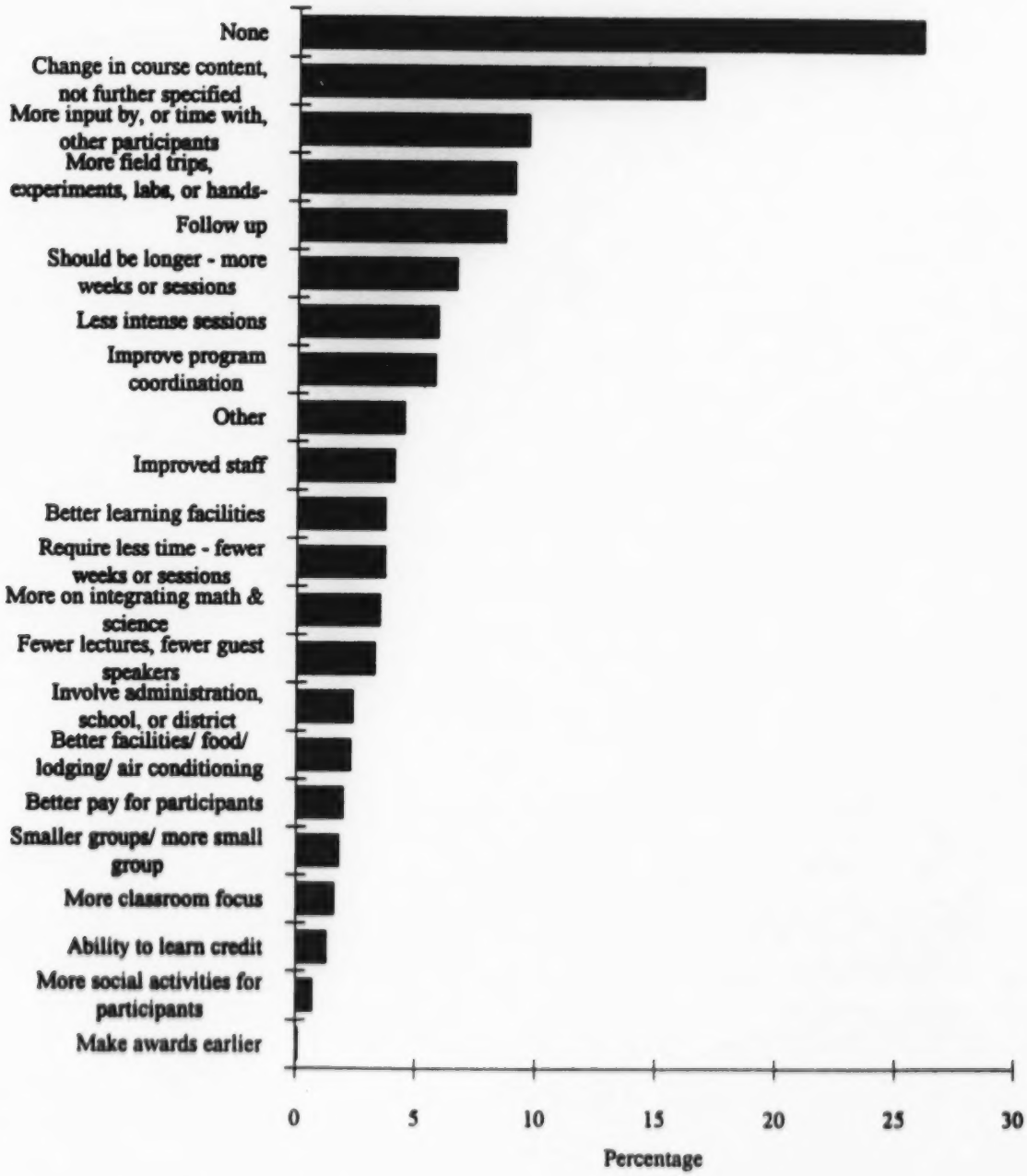
Source: Participant Survey - Item 46c

Figure 24 - Principal Investigators' Reports of Important Changes They Would Make in Their TEP Projects



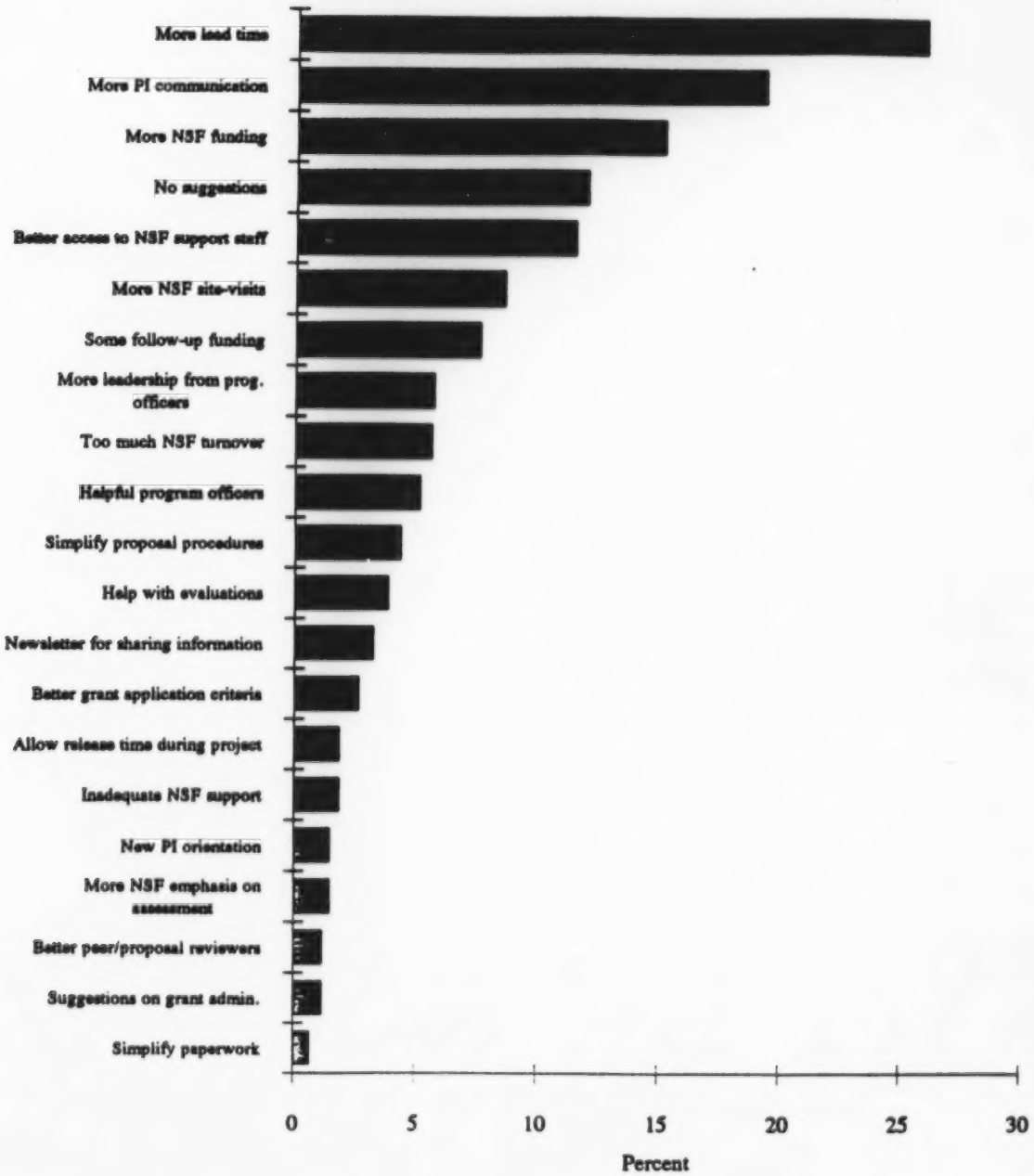
Source: PI Survey - Item 40d

Figure 25 - Participants' Reports of Important Changes They Would Like to See Made in Their TEP Projects



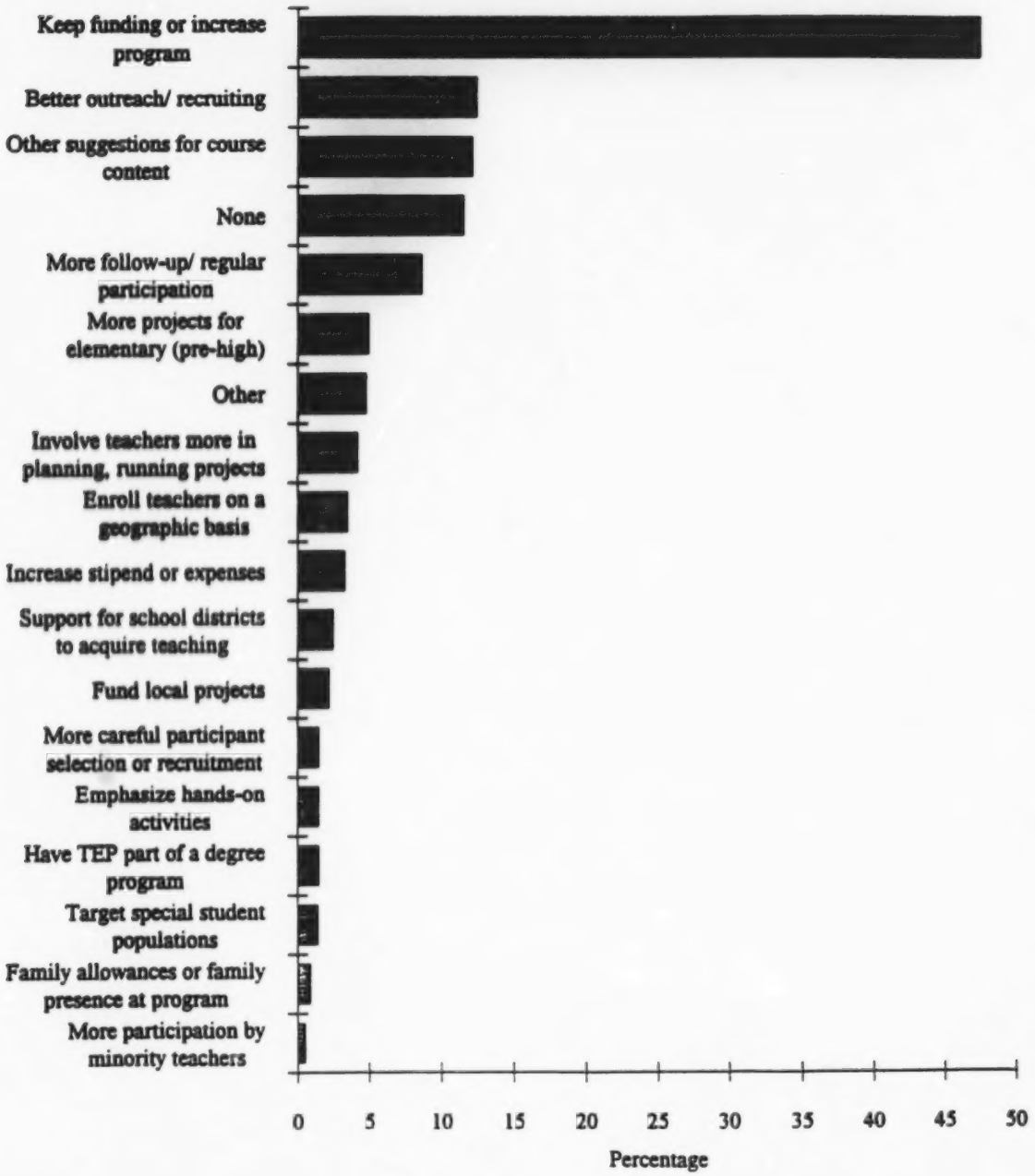
Source: Participant survey - Question 46d

Figure 26 - Principal Investigators' Suggestions for NSF Regarding Ways to Improve the Support it Provides to PIs



Source: PI Survey - Item 40f

Figure 27 - Participants' Suggestions for NSF Regarding Ways to Improve its Operation of the TEP Program



Source: Participant survey - Item 46f

Achievement of Program and Agency Objectives

It is useful to comment upon the achievement of TEP objectives from at least four perspectives: those of the Teacher Enhancement Program itself, the Division of Teacher Preparation and Enhancement (TPE), the Directorate of Education and Human Resources (EHR), and the National Science Foundation as a whole.

The TEP Programs

A variety of specific TEP objectives were achieved:

- The TEP projects clearly stimulated the development and documentation of new methods and materials for in-service education tailored to elementary, middle, and high-school teachers.

- The TEP projects provided teacher participants with opportunities to learn discipline-specific concepts and processes and effective teaching methods, as reflected in the impact assessments of the PIs.

- The PIs and participants reported as one of their major accomplishments the expansion of participants' knowledge of concepts and applications of science and mathematics.

- Many of the PIs reported recruiting outstanding classroom teachers who subsequently developed leadership skills to assist in improving the teaching practices of their less well-prepared colleagues.

- Likewise, PIs reported recruitment of less well-prepared classroom teachers with demonstrated needs and expressed commitments to pursue professional development -- an important target group for the TEP projects.

- Many of the projects provided the opportunity for teachers to share and work together in local and/or regional settings in order to improve their own teaching under the guidance of the project staff. The amount of such follow-up appeared to increase over the course of the TEP program from 1984 to 1989.

- According to the PIs and participants, the participants established continuing collaborative partnerships with faculty members of schools, colleges, and universities, as well as personnel from a variety of other public and private organizations. Representatives of museums were an especially important source of collaborative partnerships for TEP projects.

- The TEP projects gave special attention to increasing student access to careers in science, mathematics, and technology by reaching teachers who are serving populations underrepresented in the sciences, as well as teachers serving economically disadvantaged communities.

- Another frequently reported impact of these TEP projects was the deepening of participants' knowledge and their application of improved teaching methods, including an emphasis upon hands-on learning techniques and effective applications in the laboratory.

- One objective of the TEP project appeared to have been less often accomplished: participation by teachers with physical disabilities was less frequently reported than might have been hoped for by NSF.

TPE Objectives

The two major objectives of the Division of Teacher Preparation and Enhancement appeared, by and large, to have been accomplished in the TEP program:

- Based upon PI and participant reports, the TEP program appeared to have supported well-designed projects that directly benefit the teacher-participants by making them more competent in the subject matter, more comfortable in its presentation, and more committed to their profession and their pupils; and

- In the judgment of the PIs and participants, the TEP projects have added to the base of knowledge about how teachers can most effectively be prepared and subsequently aided in enhancing their capabilities.

Several operational objectives emphasized by TPE appeared to have been achieved through the TEP program as well:

- The TEP projects appeared to have capitalized on the prestige of the NSF grant and exploited the Foundation's unique familiarity and relationship with the scientific research and education community -- perhaps best illustrated by the effective leveraging of NSF funds;

- As was demonstrated by the broad base of project staff support (both paid and voluntary), the projects stimulated collaboration among such organizations as the Federal government, colleges and universities, state and local education agencies, business and industry, cultural institutions, and media, and among such partners as scientists and science educators, other teachers, school administrators, and parents;

- According to PI reports, the TEP projects have led to some self-sustaining networks among these varied elements -- cooperative patterns that will continue to function, supported by non-NSF funds; and

- The individual TEP projects did a good job of focusing resources and using in-service approaches that appeared to be widely applicable to strengthening science and mathematics education.

Many TEP projects involved the formulation, testing, and refining of various approaches to in-service education -- with three out of four PIs reporting that they utilized evaluation methods to assess project accomplishments objectively.

EHR Objectives

The Directorate for Education and Human Resources defines and funds programs and projects that support NSF's educational mission. This directorate has four long-range goals to help ensure that:

- high quality primary and secondary education in science and mathematics is available to every child in the United States;

- those who select careers in science, mathematics, and engineering have available the best possible professional education in their disciplines;

- opportunities are available at the college level for interested non-specialists to broaden their science backgrounds; and

- sufficient support is available for science education outside the classroom to encourage and maintain public interest in, and awareness of, scientific and technological developments.

The roughly 600 TEP projects included in this evaluation reached an estimated 63,000 teachers throughout the United States, at all school levels, and in a variety of communities. The TEP projects also have addressed the major subject areas of science and mathematics instruction. The TEP projects appear to have contributed to the long-range goals of EHR.

NSF Objectives

Finally, the National Science Foundation seeks to leverage application of its resources and is strongly committed to the principle of cost sharing in its projects. Cost sharing among collaborating partners is strongly encouraged for all grant recipients -- especially where the goals

include the continuation and maintenance of project activities by local institutions or self-sustaining networks after NSF funding has terminated. By achieving a 53% leverage (including both financial and in-kind contributions), the TEP projects have done especially well in this regard.

The Foundation is also especially concerned about the underrepresentation of women, minorities, and the physically disabled in careers in mathematics, engineering, and the sciences. Projects involving members of these groups as principal investigators or staff, and as participants, are especially encouraged. A large percentage of both PIs (22.6%) and participants (57.4%) are female.

TEP projects have attracted some PIs who have physical disabilities, with five percent reporting such disabilities. The percentage of TEP participants with disabilities is lower, however, with around three percent of participants having some form of physical disability.

The picture with respect to minority participation among TEP PIs and participants is less encouraging. The incidence of PIs who are members of minority groups was low (5%). Participation by minorities, according to self-reported minority status, was low, with 7.9% of participants being black, 1.7% Hispanic, and 1.0% native Americans or Pacific Islanders. Minority TEP PIs did better in attracting minority applicants than did non-minority PIs.

Implications for Changes in TEP Policies and Programs

A number of program and policy implications arise from this study.

- TPE should emphasize that prospective grant applicants need to obtain commitments of non-NSF financial or in-kind support for their TEP projects. Aside from consistency with NSF policies, such support has demonstrable benefits associated with it, including greater diversity of teaching methods (including computer-assisted instruction), development of curriculum materials, dissemination of curriculum materials, higher achievement of project goals, greater continuing use of other community scientific resources, longer term contact between PIs and participants, publication of journal articles, and continuation of support after completion of the TEP grant.

- TPE should carefully examine the program funding cycle to determine if it is possible to initiate requests for proposals under a schedule that would result in an earlier award date -- thus expanding the amount of recruitment time available to successful awardees.

- TPE may wish to examine the caseload of its program staff to insure that sufficient time is available for the provision of program support to TEP awardees.

- With respect to the funding cycle, three years appears will be appropriate. It may be useful to prepare a set of criteria for present awardees, however, indicating specifically the conditions that must be met if a project is to receive an optional, two year follow-on. In this case, there are, of course, trade-offs between maintaining a truly superior project serving a significant number of participants, versus funding a new PI who has good ideas but is untried.

- The finding that TEP projects that concentrated their focus on more delimited subject matter and grade span (especially for kindergarten and early grade mathematics) were more highly rated by participants than some of the less delimited projects deserves some examination and consideration with regard to grant application guidelines and in the screening of grant applications.

- It may be useful for TEP to determine the match between the location of the PIs (and the number and type of participants that they serve) and the distribution of school districts and various population groups. It would be especially important for NSF to know the extent to which there are significant mismatches between the location of school systems needing services and the location of PIs providing the services. One finding of this study appears especially important in this respect; female participants are less likely to be attracted to projects located far from their districts.

- TPE staff should consider steps that would increase the participation of PIs from underrepresented groups. While the population of TEP awardees would appear to include a reasonable percentage of individuals with physical disabilities, only one in five of TEP awardees is a woman, and (among awards where ethnicity or race is known), only one in ten are members of under-represented groups. (As a corollary, it is clear from the study results that PIs who are members of underrepresented groups are notably effective in recruiting participants from these same groups.)

- Turning to underrepresented groups of participants found in the TEP projects (as distinct from the PIs themselves), TPE staff should also make every effort to alert TEP PIs to the importance of actively recruiting members of underrepresented groups in science and mathematics, particularly in any local school with a higher proportion of such persons among its faculty. It is clear that where PIs do target their recruiting to districts with under-represented groups, their level of participation in the projects increases.

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